FEBRUARY

# THE JOURNAL OF THE AMERICAN DENTAL ASSOCIATION AND THE DENTAL COSMOS

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The Beneficence of Denture Restorations
The Broadening Scope of Dentistry

ASSOCIATION ACTIVITIES

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DENTAL ECONOMICS

COUNCIL ON DENTAL THERAPEUTICS

FIFTY CENTS

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THE JOURNAL *of the*
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# EFFECT OF LOSS OF VERTICAL DIMENSION ON ANATOMIC STRUCTURES OF THE HEAD AND NECK

By H. L. Harris, B.A., D.D.S., F.A.C.D., St. Paul, Minn.

THE history of the early decades of dental practice records mainly the development of technics in which the mechanics of procedure was the dominating thought; and until a comparatively few years ago, dentistry continued to concentrate its attention on the individual tooth and its investing tissues. But a change in point of view and practice is taking place. More and more, dentists are broadening their vision and coming to the conclusion that, in many cases, the mere replacement of lost tooth structure or the replacement of one or more missing teeth by bridges or partial denture work does not accomplish all that is desired and cannot be regarded as the complete service which dentistry can render. The result of this broadening of the vision is that a more complete picture of the great mechanism of mastication is formed in the average dentist's mind. We realize now that the masticatory apparatus consists of all the teeth, their investing tissues, the jaws and the adjacent structures; that the tie that binds all the sections of dentistry together, and which must be the basic study in all sections, is the study of occlusion, because occlusion is a state or condition on which a large number of anatomic structures of the head and neck are dependent for their correct anatomic position and normal physiologic function.

It would seem, then, that a knowledge of what constitutes the normal in occlusion and the normal in the anatomic form and physiologic function of the structures of the head and neck is essential. Not only is this knowledge essential, but it is also without question the basis of all oral diagnosis and restorative dentistry. For years, dentistry has had definitions of normal occlusion, most of which were concerned mainly with a description of the actual cusp contact of the teeth of the opposing jaws. In 1921, the late George S. Monson, of St. Paul, gave to

(Read before the Section on Full Denture Prosthesis at the Seventy-Ninth Annual Session of the American Dental Association, Atlantic City, N. J., July 13, 1937.)

the dental profession the first definition of normal occlusion which went beyond former limits and included consideration of associated anatomic structures. Not only did he present this and other fundamental principles of his spherical theory of occlusion, but he also gave his conception of the norm, the pattern to which nature evidently is endeavoring to build all occlusions; and, for the first time, dentists were in possession of an ideal form with which they could compare and a pattern to which they could construct.

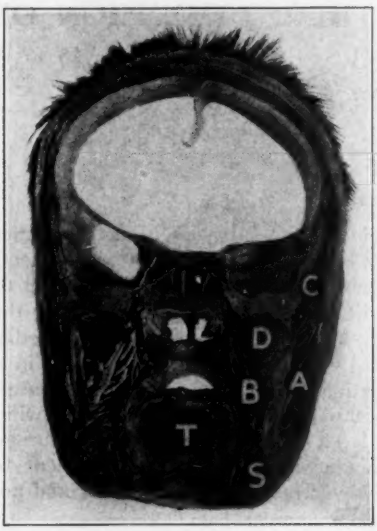



Fig. 1.—Frontal section of head through area of coronoid process. A, masseter muscle. B, internal pterygoid muscle. C, temporal muscle. D, cross-section of fibers of external pterygoid muscle. T, tongue. S, submaxillary gland. This view shows that the temporal, masseter and internal pterygoid fibers are vertical and the external pterygoid fibers are horizontal.

Restoring vertical dimension of the face is one of the fundamental principles of the spherical theory of occlusion. To appreciate fully the effects of loss of vertical dimension of the face, we must have in mind three fundamentally important facts: first, that there is a difference between the norm and the normal; second, that there is a distinct relationship between the structure and form of living bone and the forces exerted by muscle action, and, third, that the basic sciences of anatomy and physiology linked together with clinical practice and experience are the basis for a clear understanding of the importance of restoring lost vertical dimension.

Let us consider these three points further. First, there is a difference between normal and the norm. The normal in form and function of the teeth and associated structures in each individual is

Fig. 2.—Case with far from normal occlusion. However, owing to the end to end relationship of a few of the teeth, not more than 2 or 3 mm. of vertical dimension has been lost and the condyles should be considered Class I.

determined by the degree of efficiency which he attained at the height of his development. By development, I mean that series of changes which take place from the time of fertilization to the adult stage or until full growth is reached.

It has been apparent through research done in the past that Nature has a definite plan in the development of the teeth and jaws. This is true in the development of all living forms. The finest specimens of any living form to be found in nature

are those which have reached the height of their development with perfect symmetry and contour. These specimens experienced a minimum of disturbing influences in their environment and are the forms by which is rightly judged the height of development attained by other forms in the same species. The most beautiful tree, for example, is one of perfect symmetric and contoured growth, but because of the hazards of the elements, wind, rain and lack of moisture, and parasites, pathologic growths and other detrimental influences in the environment, comparatively few trees reach this ideal form.

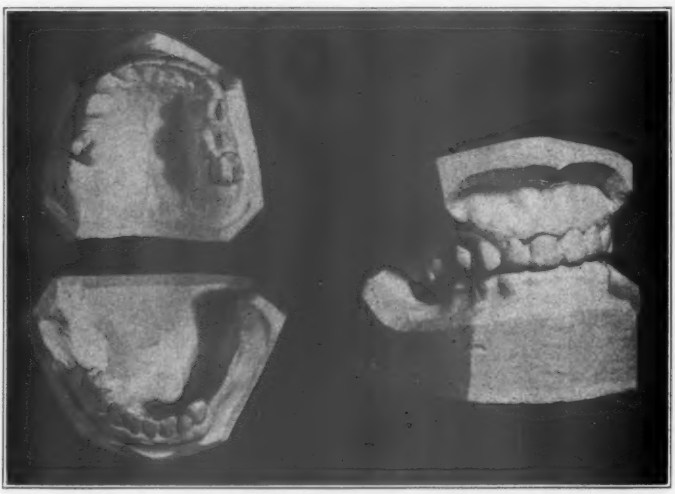


Fig. 3.—Type of occlusion considered to be Class II; loss of posterior units, excessively deep overbite, with marked inclined plane force of labial aspect of lower anterior teeth against the lingual aspect of the upper anterior teeth, gradually forcing the condyles upward and backward in the glenoid fossae. There is an estimated loss of vertical dimension in this case of from 6 to 8 mm.

The same principles hold true throughout the animal kingdom, especially in the higher or more complex forms, and particularly in the human being. Thus, the finest specimens of the human mandible and maxillae are found in those persons who, at the age of from twenty-five to thirty, have reached the height of their development or highest point of efficiency. These specimens have perfect symmetry, with a full complement of teeth in good occlusion, thus producing the normal for that individual in vertical dimension and contour of the face, and placing the muscles of the masticating mechanism in their proper physiologic position. These specimens are the forms on which a definition of the norm is based, which, according to Monson's conception, is a well developed, muscularly balanced mandible, the Bonwill triangle of which is equilateral, with a full complement of teeth whose occlusal surfaces conform to the base of a spherical pyramid, the point of which is the common center toward which all forces are directed.

Because of disturbing influences present during the formation and development of the teeth and detrimental changes which occur after their eruption, such as dental caries, abrasion of the teeth, loss of teeth, abnormal habits, faulty dental care and disturbances in

metabolism, comparatively few persons reach the ideal in development.

### FORM AND FUNCTION

The specialty of orthodontia has been developed in dentistry because there are so many deviations from the ideal. Likewise, dentists in general practice have an opportunity to make corrections in adults by reconstruction of the natural occlusion or in the construction of artificial dentures. When deforming influences mentioned above have caused a loss in vertical dimension of the face, there are evidences of an anatomic relationship which does not permit proper function of the mandible, tongue and adjacent anatomic structures.

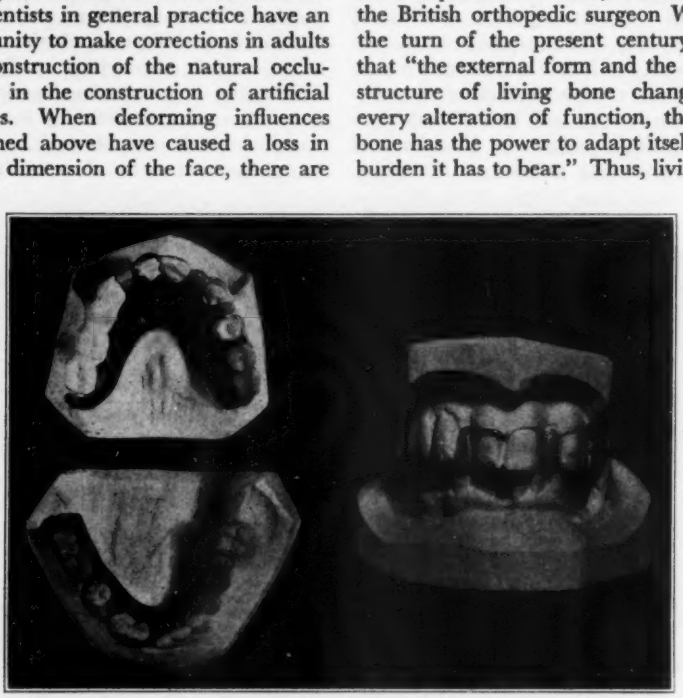


Fig. 4.—Another type of occlusion placed in Class II, in consideration of the effect of loss of vertical dimension on the condyles. Loss of posterior units, faulty dental work, and abrasion have contributed to an estimated 7 mm. loss of vertical dimension and a diagnosis of abnormal relationship of structures in the glenoid fossae.

Secondly, the effect of muscle pull on bone is an important consideration. In the opinion of those who believe that the occlusion of the teeth determines the conditions in the glenoid fossa, there is too much tendency to consider the mandible as an unyielding, unchanging, case hardened structure, as is evidenced by cases constructed to habitual movement of the mandible and adherence to fixed condylar paths. Because the mandible is a living bone, it is subject to the laws which apply to other living bones. One of the most important of these, formulated by the British orthopedic surgeon Wolff, at the turn of the present century, states that "the external form and the internal structure of living bone change with every alteration of function, that is, a bone has the power to adapt itself to the burden it has to bear." Thus, living bone is a plastic tissue in which demolition and rebuilding are taking place in all parts.

This principle that muscle stress has considerable effect on the shape of bones is further substantiated in embryology, in which it is recognized that, in the facial region, cells migrating from the neural plate become specialized as muscle fiber cells and become polarized in the direction of future muscle action. Thus, the muscles of mastication are formed and function

while the mandible is still composed of cartilage; and, as ossification takes place, the mandible adapts itself to the forces exerted on it by the muscles. A little farther along in this paper, I shall discuss some research work that I have been doing on the temporomandibular joint which I believe further illustrates the fact that an alteration in the function and relation of the mandible to the maxilla has a decided effect on the normal functions in the glenoid fossa.

Fundamentally, anatomy and physiology combine to form the basis for both dentistry and medicine. Of the two healing professions, however, medicine has made a far greater application of the knowledge that these sciences contribute than has dentistry. In fact, if one studies the history of anatomy and physiology, he finds it is closely associated with the history of medicine. Each advance made in anatomic knowledge has marked an advance in surgery. As each new organ, structure or tissue was accurately and thoroughly described and its function studied, surgery absorbed this knowledge and became more proficient and of greater service to humanity. The high degree of development which the science of anatomy has reached today is accountable for the fact that modern surgery has reached its greatest heights. The good surgeon is a good anatomist, and his surgical technic is based upon his knowledge of the anatomy and physiology of the parts. A good orthopedist is a good anatomist. He knows the form and function of the structures in his fields, and his efforts to correct deformities are based fundamentally upon that knowledge. Whatever mechanical devices he may use are secondary in consideration and are designed to bring his patients back to as nearly a normal condition as his skill and the conditions in the case permit. The same is true for the internist, the eye, ear, nose and throat specialist, the neu-

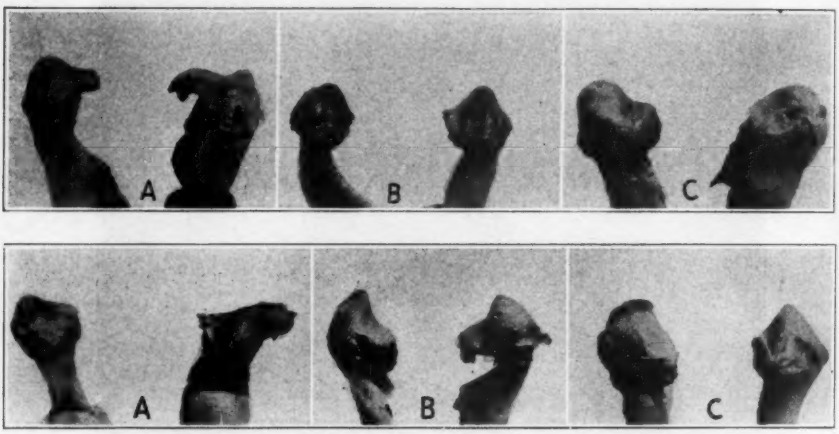
Fig. 5.—Also a Class II type of occlusion. Here, loss of upper posterior units, replaced by a partial denture which has settled under continuous pressure of occlusion, heavy abrasion on lower teeth, both anterior and posterior, and shifting of upper anterior units labially have contributed to an estimated loss of 6 mm. of vertical dimension.

rologist, the dermatologist, etc. Their knowledge of form and function in their respective fields is fundamentally their most valuable asset.

If this knowledge has been so valuable to the progress of medicine, why has it not been so utilized in dentistry? Why does not the dentist, like the orthopedist, think in terms of anatomic form and physiologic function? Because dentistry developed mechanically minded and concentrated its attention on the individual tooth and investing tissues. If we as a profession are ever to be held by the public in the same high esteem as the physician, the surgeon and the orthopedist, we must change our point of view. Oral diagnosis must be given more consideration; and if we as dentists are to be more efficient as diagnosticians, we must have a broader concept of the form and function of the anatomic structures in our field.

Vertical dimension of the face is a phrase in dental terminology ordinarily used to designate the measurement from the base of the nose to the base of the chin when the teeth are in centric occlusion. This is the portion of the face which changes most in life, owing entirely to detrimental changes which alter the occlusion. This dimension is strictly dependent on the stop or occlusal rest in the closing movement of the mandible. It is dentistry's responsibility to determine where that stop shall be, whether we are straightening the malposed teeth of children, reconstructing natural occlusion or constructing artificial dentures. The conditions which bring about the loss of vertical dimension are the wearing down or abrasion of the teeth, loss of posterior teeth, resorption of ridges under dentures and faulty dental work.

Let us now consider the effect of the




Figs. 6 (above) and 7.—A: Left and right condyles and menisci from Class I cases. The necks of the condyles are straight and the menisci are placed directly on top of the condyles, acting as a buffer in the various ranges of movement. B: Left and right condyles and menisci from Class II cases. The bend in the necks of the condyles and forward inclination of the menisci indicate a changed relationship due to loss of vertical dimension and consequent increased pull on both heads of the external pterygoid. C: Left and right condyles and menisci from Class III cases. The pull of the sphenomeniscus (upper) portion of the external pterygoid muscle has dragged each meniscus so far forward that it has become a factor in mandibular movements only in the protrusive ranges. The condyle has also been pulled forward and loss of vertical dimension has forced condyles upward and backward in the glenoid fossae so far that the condyles in Figure 7, C, have developed a lateral bend also, as seen in the posterior view Figure 8, B.

loss of vertical dimension of the face on various groups of muscles. For a clearer understanding, consider first the physiology of muscle fiber.

### RELATION OF THE VERTICAL DIMENSION TO THE FACIAL MUSCLES

There are various types of muscle fibers in the body. Regardless of the manner in which we may attempt to classify them, they fall into three distinct groups, namely, skeletal, smooth and cardiac. If we classify them histologically, the skeletal muscle fibers are found to be striated, with scattered nuclei. The smooth muscle appears as a band of fibers without striation, and the cardiac muscle has the characteristics of both the striated and the smooth muscle. Classified according to function, we find the skeletal muscle, with few exceptions, originating from some fixed portion of the skeleton and attached to some movable part. The contraction of these fibers results in the movement of the parts. Smooth muscle fibers comprise the muscles encircling the various body cavities, such as the internal organs and the blood vessels. Cardiac muscle is obviously only in the heart, and therefore it is not necessary to discuss it further.

If we classify these muscles according to their relation to the central nervous system, we find that skeletal muscle is supplied by the cranial nerves and is for the most part voluntary; in other words, under control of the will. Smooth muscle is supplied by the autonomous or sympathetic nervous system and is involuntary, contracting and expanding from impulses generated probably by the contents of the body cavity with which they are associated.

The muscles associated with the mouth and throat are composed entirely of skeletal muscle fibers. Thus, we find from the study of physiology of skeletal muscle fiber that certain things which have an important bearing on our work are true. Space does not permit a discussion of the many important physiologic characteristics of skeletal muscle such as chemical action within the muscle fiber, nutrition, the phenomenon of fatigue and tetanus; but one of the most important, and one which has an important bearing on our subject, is the fact that skeletal muscle functions properly when the normal distance is maintained between the origin and insertion of the fibers, and that this type of muscle loses tone and strength when the distance between these two

Fig. 8.—Posterior views of condyles and menisci shown as Class III cases in Figures 6 and 7, C. A: Posterior view of Figure 6, C. The patient was edentulous, the length of time unknown. The denuded area and exposed portion of the condyle indicate that bone was working against bone in the glenoid fossa. Wear is through the tissue of capsular ligament and not through the meniscus, no part of which is visible in this view. What value could be placed on a tracing of the paths of these condyles? B: Posterior views of Figure 7, C. The tissue visible here on the condyle is capsular ligament. The meniscus, as in A, is lying on the anterior aspect of the condyle. This patient was also edentulous for an unknown length of time. Each condyle has a denuded spot, not so large as in A, but this is probably due to a lateral bend developed in the neck of the condyle which reduced the pressure of the condyle on the floor of the glenoid fossa.

points is shortened. Conversely, tone is increased beyond normal when the distance between origin and insertion is increased. I refer you to any good work on physiology for the verification of that statement.

In a closed bite condition in which there is loss of vertical dimension, the condyle is forced upward and backward in the glenoid fossa. Facial evidence of this is shown by shortening of the lip, which means that the distance between the origin and the insertion of the group of muscles known as the muscles of expression is lessened. This group is made up of thin flat bands of skeletal muscle fibers which are concerned with the various expressions of the face and the shape of the upper and lower lips. When vertical dimension has been restored and the mandible placed in its proper position, the lips return to their normal length. Therefore, it is obvious that to use the lip line as a guide for the placing of artificial teeth is fundamentally wrong, because the condition of the lip in the closed bite condition is a changing one.

Fig. 9.—Mrs. A. H. W. wearing original complete upper and lower dentures obviously built to short bite. There is drooping of the corners of the mouth, with compression of the lips, reducing their length and at the same time shortening the distance between the origin and insertion of the muscles of expression. Setting the teeth to the lip line in such cases can result only in the dentures having too short a vertical dimension. In this case, the vertical dimension was 59 mm. (base of nose to base of chin).

Loss of vertical dimension affects in a similar manner the anatomic structures known as the pendant muscles of the mandible. This group of muscles runs from the lower borders of the mandible to the hyoid bone and from the hyoid bone to structures below. The muscles from the mandible to the hyoid bone are known as the suprahyoid group and are composed of the geniohyoid, mylohyoid and digastric and include also the stylohyoid. The group below the hyoid bone is known as the infrahyoid group and is likewise composed of four muscles, the sternohyoid, the omohyoid, the thyrohyoid and sternothyroid. Thus, Nature has arranged a muscle mechanism in sets of four which is concerned chiefly with mandibular movements. To open the jaw, the infrahyoid group becomes set and holds the hyoid bone rigidly in position. The suprahyoid group contract and the mandible is opened. It has been pointed out that the mandible acts similarly to a sack holder for these groups of muscles and their normal positions are altered by its displacement.

A review of the muscles of mastication (Fig. 1) will reveal that when there is a shortening of the bite, or, in other words, a loss of vertical dimension, the distance between the origin and insertion of three of the four muscles of mastication is shortened, because they are the vertical muscles; namely, the temporal, whose origin is in the temporal fossa, the fibers converging fanlike to be inserted on the coronoid process and the anterior face of the ramus of the mandible; the masseter, whose fibers originate on the zygoma and

are inserted on the lower half of the lateral surface of the ramus of the mandible, and the internal pterygoid rising from the distal surface of the lateral pterygoid lamina and inserted in a triangular impression on the medial surface of the ramus of the mandible. However, in the case of the external pterygoid muscle, this distance becomes lengthened because the fibers of this muscle have their origin on the infratemporal surface of the great wing of the sphenoid and a part of the lateral pterygoid and lamina of the pterygoid process, and run horizontally to be inserted in the meniscus and the condyle. Therefore, the first three named lose tone, but the latter gains in strength. Likewise, it would follow that overactivity on the part of any muscle would change that bone to which it is attached, and this is true in the case of the external pterygoid and its attachment on the condyle and meniscus. When the vertical dimension is shortened and the mandible is allowed to be thrust upward and backward, the distance between the origin and the insertion of the external pterygoid is increased. Therefore, the tone of the muscle is increased, and a greater pull is exerted on the condyle. If we recall also that the thinnest part of the mandible is just below the condyle in what is known as the neck of the condyle, and applying Wolff's law that the external form and internal structure of living bone is determined by the muscular forces put on it, we must expect changes in the position of the condyle and meniscus. Does this occur? To answer this, I shall present some observations made in research on the subject.

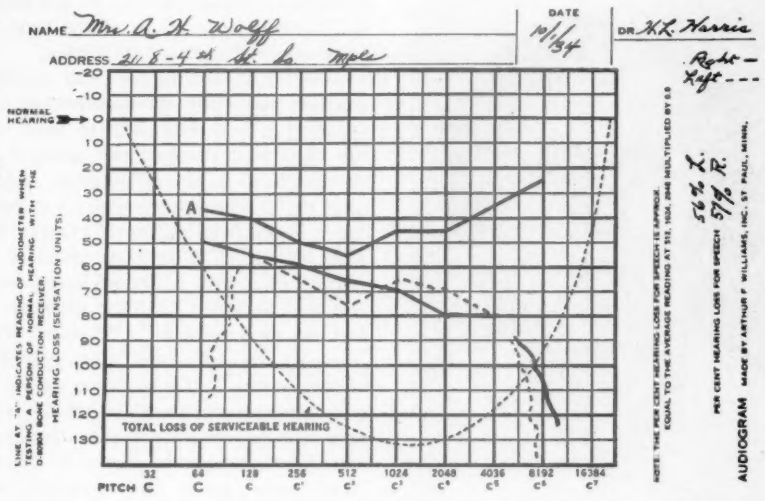



Fig. 10.—Audiometer reading made for Mrs. A. H. W. (Fig. 9) when she was first seen. The line at A is printed on all standard audiometer cards. The broken line indicates the reading of the left ear, the unbroken line, the reading of the right ear. This reading shows a loss of 56 per cent in hearing efficiency in the left ear, and a loss of 57 per cent in the right ear.

## LABORATORY STUDIES

Several years ago, the opportunity was given me to study anatomy and dissection in the Department of Anatomy at the University of Minnesota. The material used for this investigation was the

cadavers used for dissection by the dental and the medical students. Because of this fact, it was impossible to carry on the research work as I would have done had the material been my own. In that case, the mandible, condyles and menisci would have been carefully removed and kept intact so that, at any time, a clear picture of the relationship of the occlusion to the glenoid fossa could have been studied. However, it was necessary to do this work without interfering in any way with the students' dissections. The procedure was as follows:

Fig. 11.—Photograph of patient (Fig. 9) on day new complete upper and lower dentures were inserted. The vertical dimension has been changed to 72 mm., an increase of 13 mm. There is evidence of increase in vertical dimension in the strained appearance of the lips, but the muscles and other anatomic structures began to adjust themselves immediately, and in a few days the strained appearance disappeared.

Each year from eighteen to twenty cadavers are utilized for the class work of dental students in the Department of Anatomy, and as these cadavers were laid out on the tables, an examination was made of the occlusion of each. The subjects have all been males, between the ages of approximately fifty and seventy-five. The teeth were carefully charted and as much information as could be gleaned from visual examination was noted; that is, the number of teeth present and their location, number of missing teeth, amount of abrasion appearing on the teeth, the condition of the bite, whether protrusive, end-to-end or overbite, amount of this overbite, the drift of teeth and the forces combining to produce malocclusion. An estimate was made in each case of the approximate amount of vertical dimension lost. It was impossible to take impressions of the teeth because of the fixation of the tissues.

After this information was carefully charted, including the number of each cadaver, it was necessary to wait until the class had reached the area of the glenoid fossa in their dissection. At the time the students were ready to remove the condyles from the glenoid fossae, they were instructed to keep as much of the ramus intact with the condyle as possible and also to try to keep the meniscus intact on each condyle. Of course, many condyles were removed with very little of the ramus left. In some cases, the meniscus was destroyed either by faulty dissection or from a natural curiosity for which the students could not be blamed. Nevertheless, many fine specimens were recovered. When the day arrived for this part of the dissection, I was notified and was present in the laboratory, going from one table to another as the students removed the condyles. This allowed me the privilege of seeing the glenoid fossa immediately after the condyle and meniscus were removed. I immediately made a chart of conditions found there in regard to any changes that were apparent, such as perforation of the tympanic plate and denuding of the bone on the floor of the glenoid fossa. Bottles were prepared with preserving fluid and carefully numbered to correspond to the number of the ca-

daver, and the condyles and menisci were placed in these bottles for future study. Then a careful examination of each condyle and meniscus was made, and the relationship to the occlusion of the teeth was observed.

An attempt has been made to classify these condyles, but as yet a satisfactory method of classification has not been decided on. At the present time, I have divided them into three classifications. Class I comprises those condyles removed from cadavers in which there was a normal occlusion. By that, I mean cases in which all teeth were present and there was a minimum amount of abrasion on the teeth, and any other cases (Fig. 2) in which one or two teeth may have been lost but it was apparent that not more than 1 to 2 mm. of vertical dimension had been lost. This class has been found to include approximately 15 per cent of the total number studied.

Class II contains that group of specimens which presents the greatest problem of classification. At the present time, it contains the great majority of specimens studied and must necessarily be broken down into smaller classifications. Cases in which several teeth have been lost, cases in which there has been an apparent loss of from 3 to 10 mm. of vertical dimension, and those cases presenting deep overbites have made up the bulk of this classification (Figs. 3-5). This group includes approximately 70 per cent of the specimens studied.

Class III includes those cases which present from 10 mm. to a maximum of vertical dimension lost. By maximum, I mean the few remaining teeth have been worn down by abrasion approximately to a gingival line. Included in this group are the large number of cases which were edentulous. In the edentulous cases, it seemed logical to assume that, because of the economic status in life, very few of these subjects were able to have dentures made, or if dentures were made, they were quickly and cheaply constructed; in

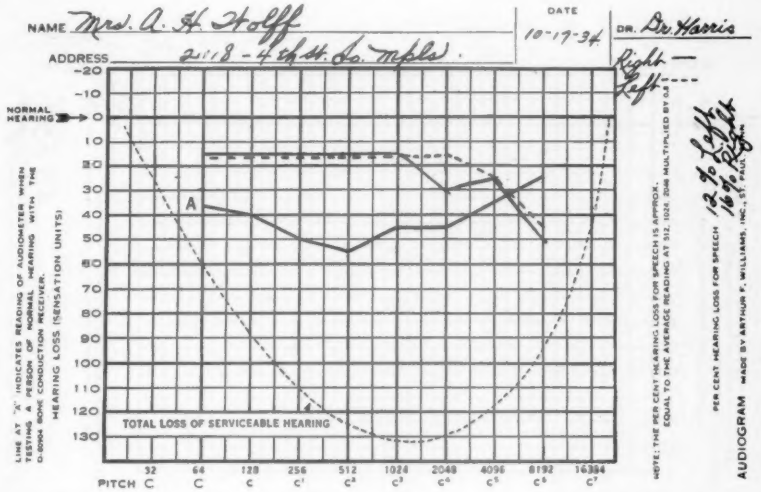

NAME Mrs. A. H. Holff
DATE 10-17-34
DR. Dr. Harris
ADDRESS 2118 - 4th St. So. Mpls.
Right —
Left ----
NORMAL HEARING
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
A
TOTAL LOSS OF SERVICEABLE HEARING
HEARING LOSS (SENSATION UNITS)
LINE AT "A" INDICATES READING OF AUDIOMETER WHEN TESTING A PERSON OF NORMAL HEARING WITH THE O-BONE CONDUCTION RECEIVER.
PITCH C 32 C 64 C 128 C¹ 256 C² 512 C³ 1024 C⁴ 2048 C⁵ 4096 C⁶ 8192 C⁷ 16384
NOTE: THE PER CENT HEARING LOSS FOR SPEECH IS APPROX. EQUAL TO THE AVERAGE READING AT 512, 1024, 2048 MULTIPLIED BY 3.5
PER CENT HEARING LOSS FOR SPEECH
12 % Left
16 % Right
AUDIOGRAM MADE BY ARTHUR F. WILLIAMS, INC., ST. PAUL, MINN.

**Fig. 12.—Audiometer reading made the day new dentures were inserted. There is an increase of 46 per cent efficiency in the left ear and of 41 per cent in right ear, which the patient always spoke of as her "bad" ear.**

which case, it is likewise probable that little attention had been paid to building a proper vertical dimension in the case.

In Class I (Figs. 6, A and 7, A), the condyles and menisci have been found in the position illustrated in various textbook anatomies in which the authors have attempted to illustrate the normal; that is, the condyle upright and the meniscus placed squarely on top of the condyle acting as a buffer between it and the floor of the glenoid fossa. If the teeth have been in good occlusion and there has been a minimum amount of vertical dimension lost, no deviations from this normal picture have been found.

In Class II (Figs. 6, B and 7, B), in which there has been apparently from 3 to 10 mm. lost in vertical dimension and an apparent upward and backward displacement of the mandible and condyles, it has been found that there has been a bend forward in the neck of the condyle, indicating that the backward thrust of the condyle has been opposed by muscular force tending to change the shape of the bone in the region of the neck of the condyle. Likewise, it has been found that this same muscular pull (external pterygoid) that has caused the bend in the condyle has likewise pulled the meniscus forward so that the articulating surface of the meniscus, instead of presenting the practically horizontal position as seen in Class I, has been approaching more a 45 degree angle anteriorly. However, in no case of Class II has there been evidence that the meniscus has been worn through or that there has been any damage done to the tympanic plate in the glenoid fossa.

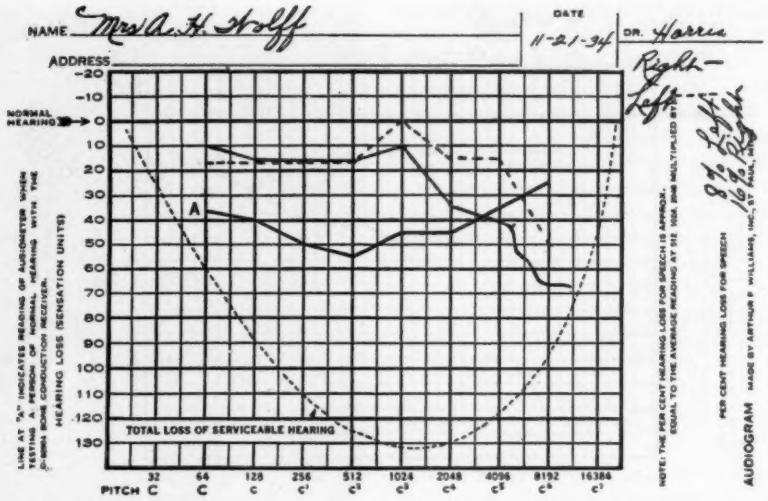



Fig. 13.—Audiometer reading made a few days over one month after insertion of new dentures. The left ear had improved an additional 4 per cent and right ear was maintained at 16 per cent improvement.

In Class III (Figs. 6, C and 7, C), those cases in which there has been an apparent loss of from 10 mm. to a maximum loss of vertical dimension, was found the greatest destruction in the glenoid fossa. These were the cases of badly broken down occlusion, mouths in which there were just fragments of teeth left and

those cases which were edentulous. When these are compared with the Class I condyles, it is readily apparent that a tremendous change has taken place in the shape of the bone, in many cases not only of the condyle itself, but also and particularly in the neck of the condyle. Muscular pull, that is, the power of the external pterygoid, has opposed the increased backward thrust of the mandible, and in those cases in which the tone of this muscle has been increased beyond normal, a decided bend in the neck of the condyle is apparent. Several of these parent that this increased muscle pull has likewise literally dragged the meniscus forward, so that it enters in and becomes a factor in mandibular movement only in the protrusive range of the mandible. In one or two cases, it was very apparent that the meniscus itself had been dragged completely off the head of the condyle and the major portion of its body was lying on the upper head of the external pterygoid muscle. In only two cases in this series of more than 100 sets of condyles has a perforation of the meniscus itself been found.

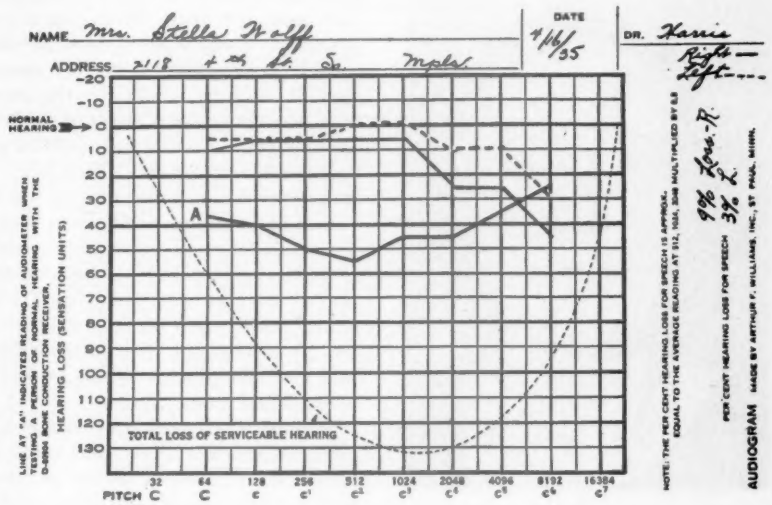



Fig. 14.—Audiometer reading taken six months after vertical dimension was increased. The left ear improved further to only 3 per cent loss of hearing, and right ear to only 9 per cent loss.

cases show that the condyle has been forced upward and backward in the glenoid fossa into the non-articulating portion of that fossa; the posterior portion (Fig. 8, A and B) of the capsulary ligament has been worn through, and the articular membrane on the floor of the glenoid fossa has been worn through so that bone has been working against bone in the various ranges of the mandibular movement.

In these cases, it has been readily ap-

These two cases were in Class III, and both of the perforations appeared not in the center of the meniscus as usually described in anatomy, but on the extreme lateral border. Since this entire series of cases has covered every conceivable condition of occlusion, I feel warranted in saying that the statement appearing in a standard anatomic textbook that it is normal for the interarticular disk, or meniscus, to be perforated so that synovial fluid can pass from one portion of the

articular cavity to the other is not based upon fact; but, rather, that such a perforation, when found in the meniscus, is evidence of an abnormal relationship of the parts. Having carefully watched the removal of each pair of condyles, I have likewise observed not one instance of a perforation of the tympanic plate, even in the few cases in which it was evident that bone was working against bone in the various ranges of mandibular movement. The explanation for this is, I believe, first, the fact that these changes

**Fig. 15.—Photograph of patient taken at time of audiometer reading in Figure 14. The tissues of the lips and mouth are "ironed out" as the striated muscle fibers have regained their tone. Could one doubt that mental attitude of patient has likewise improved?**

which take place in the glenoid fossa are not sudden, but a slow gradual process due to the continual breaking down of the occlusion, and, second, the bone of the floor of the glenoid fossa is adaptable to the pressure it has to bear (Wolff's law).

The change from the normal relationship in the glenoid fossa to conditions found as described in Class III is a slow and long drawn out process. If the change to these abnormal conditions could occur in a comparatively short time, it is conceivable that the tympanic plate or other processes of the floor of the glenoid fossa might be perforated, but as the change is a slow one, it is logical to believe that the bone changes its position to adapt itself to the pressure it has to bear.

I realize that an outstanding anatomist has described perforations of the tympanic plate, but this demonstration has always been made on dried and cleaned specimens and never on what is known as a fresh specimen. Since this cleaning process is a vigorous one and the bones must be boiled, treated, etc., it is probable that, in an area where the thickness of bone may have been changed to that of tissue paper, a perforation could be made by the cleaning process. That bones can change in this cleaning process has been known for many years. Herman Welcher, a famous German anatomist, wrote, in 1890, that a mandible that goes through the cleaning process loses from 1 to 2 cm. of width from condyle to condyle. I use this to illustrate the enormous change that can take place in bones as they undergo this process.

It must be remembered that many of these subjects may have developed some malocclusion as soon as the permanent teeth were erupted. In that case, no change may have occurred in the position and shape of the condyles and the glenoid fossae other than changes that might have come from the malocclusion progressively becoming more severe. In other words, the structures in the glenoid fossa apparently developed in accord with the development of the occlusion, since in no case of a Class II or Class III occlusion have the structures of the glenoid fossa presented a normal picture as is found in the Class I cases.

After carefully studying 100 sets of condyles and menisci and conditions in the glenoid fossae from which they were

removed, I have reached the following conclusions:

1. Since in no instance has a Class II or Class III case had a condyle and meniscus presenting a normal picture as found in Class I cases, it is apparent that loss of vertical dimension due to the conditions mentioned previously produces changes in the glenoid fossa that must be considered abnormal.

2. These abnormalities become progressively more severe as the occlusion continues to break down and the greatest deviations from normal are present in those Class III cases in which there is a loss of vertical dimension ranging from 10 mm. to the maximum.

3. Since 85 per cent of the total number of 100 cases studied are placed in Class II and Class III, it is evident that restorative work such as fixed bridgework, partial or full denture prosthesis built to habitual mandibular movements and fixed condylar paths, with no change in vertical dimension, is built to the recorded path of a deformed bone.

4. Restorative work placed in the mouths of patients of these types, in which the vertical dimension is not increased, will merely perpetuate the existing deformity.

5. The restoration of vertical dimension which relieves the pull of the external pterygoid on the condyle and meniscus allows the temporal, masseter and internal pterygoid muscles and associated muscle groups to recover lost tone and reestablishes muscular balance of the mandible.

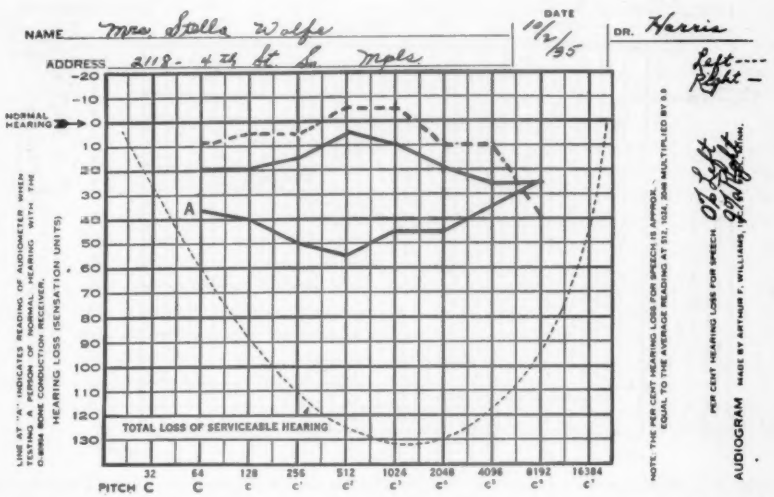



Fig. 16.—Audiometer reading made one year after construction of new dentures to increased vertical dimension. The vertical dimension at this time was 70 mm., a loss of 2 mm. due to milling and settling of denture bases. The left ear improved further to normal, the right ear maintaining itself at 9 per cent.

6. The law of orthopedics known as Wolff's Law applies to the mandible as well as to other living bones; which indicates that the condyle, neck of the condyle and meniscus will straighten up and return to normal position when vertical dimension is restored, because Nature is always attempting to establish an equilibrium. In Class I cases, the condyle and

meniscus are in a state of equilibrium; that is, the normal tension or pull of the external pterygoid is balanced by the tension of the capsulary ligament and only restoration of lost vertical dimension to a Class II or III case can bring this condition about.

However, in a number of cases of this backward thrust of the condyle, it is apparent that there is a generally lowered tissue tone, and the pull of the external pterygoid is not sufficient to change the position of the condyle. In these cases, we find that the head of the condyle tends to close up the external auditory meatus and that an impaired hearing from abnormal relationship results.

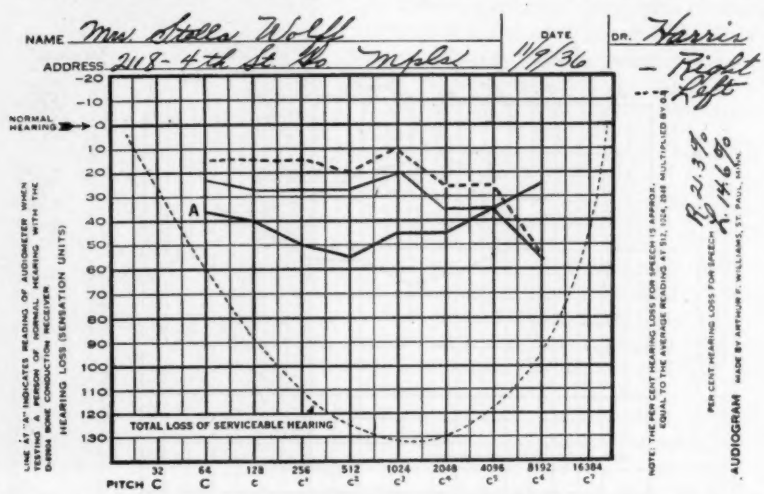



Fig. 17.—Audiometer record made two years after construction of dentures. There is a reduction in efficiency of the left ear of 14.6 per cent and of the right ear of 21.3 per cent loss. The vertical dimension at this time was 67.5 mm.; which indicates that somewhere between 70 and 67.5 mm. is a point at which this patient's vertical dimension should always be maintained.

### ANATOMY OF THE EAR

The relation of the condyle to the ear and the possible result of impaired hearing is a subject which demands much more research than has been done in the past. The fact that there are certain cases in which impaired hearing can be relieved by the proper positioning of the mandible is sufficient evidence that the dental profession should encourage this research. Not only is the relation of the condyle to the external auditory meatus important, but also the relation of the act of deglutition to the function of the eustachian tube and the manner in which it is associated with the ear must be understood to comprehend fully the importance of this particular phase of this discussion.

The ear is divided into three parts; namely, the external, middle and internal ear. The external ear consists of the auricula and the external auditory meatus, a tube approximately 24 mm. in length, of which the outer one-third is cartilaginous and the inner two-thirds completely encased in bone. The backward thrust of the condyle brings it into that area of the tube protected only by cartilage, and, instead of the characteristic round opening in the external auditory meatus, an elliptical slitlike opening results.

The middle ear extends from the tym-

panic membrane or drum to the internal ear and contains the small chain of ossicles associated with the propagation of sound waves or impulses to the auditory nerve. This chain of osseous structures, malleus, incus and stapes, transfers the impulses that come to the tympanic membrane to the spiral canals of the inner ear. However, it is into this portion of the ear that the eustachian tube enters from its origin on the level of the inferior concha of the nasal pharynx. This area depends on the physiologic functioning of this tube for drainage and the equalization of air pressure on either side of the tympanic membrane.

The internal ear is composed not only of the spiral canal which contains the minute mechanism for the actual passage of the impulse to the cochlear nerve, but also the semicircular canals and the mechanism for equilibrium associated with the vestibular nerve, these two nerves combining to form the auditory, or eighth, cranial nerve. The shortening of the bite or loss of vertical dimension likewise impairs the act of deglutition, and, therefore, has a direct effect on the physiologic function of the eustachian tube.

After the teeth are shortened or lost, the bite is closed and the mandible is moved upward and backward; which decreases the amount of tongue room and forces that organ and all associated structures posteriorly, lessening the intensity of normal activity of the act of deglutition. This being true, the activity of the tensor veli palatini and the levator palatini muscles is impaired. These muscles have their origin on the sides of the eustachian tube, which, as stated above, is a tube running from the nasal portion of the pharynx to the middle ear, approximately 37 mm. in length, the anterior two-thirds of which is cartilaginous and the posterior third encased in bone. The above-mentioned muscles originate from the cartilaginous parts of the tube and are inserted in the soft palate, and by their contraction and release, the tube

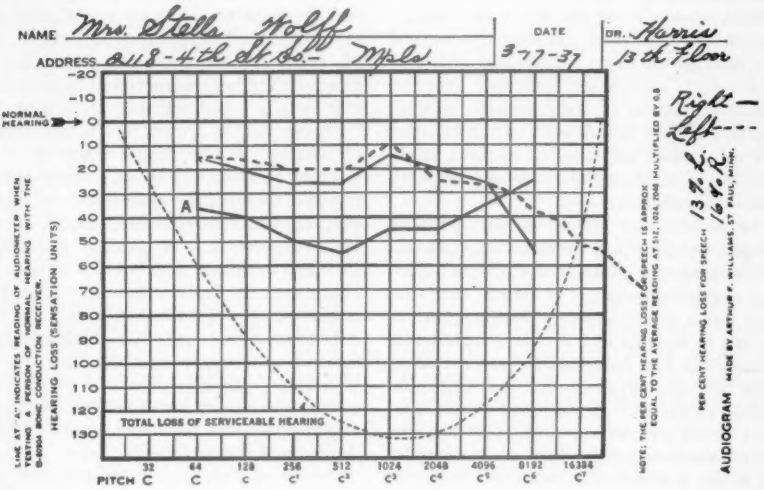



Fig. 18.—Audiometer reading following rebasing of both dentures to restore vertical dimension to 72 mm., measurement at time two years previous when new dentures were inserted. There was an immediate increase in efficiency of each to the level obtained at the time the new dentures were inserted (Fig. 12).

is opened and closed. Any condition which interferes with this physiologic action interferes with the drainage of these parts and is corrected by the restoration of the mandible to its normal position.

### REPORT OF CASE

Mrs. A. H. W., about fifty years of age, came in October 1, 1934, wearing a full upper and lower denture and requesting that new ones be constructed. The dentures she was wearing had been constructed less than a year previously and she was much disappointed because lines were appearing in her face. She also expressed the desire to know whether there was any possibility of a relationship between her teeth and the loss of hearing.

Examination showed that the dentures had been built to too short a bite, and measurements which were taken indicated that the vertical dimension of the face was 59 mm. (Fig. 9). Digital examination of the external auditory meatus indicated a decided backward thrust of the condyles when the teeth came into centric occlusion.

The patient was sent to an ear specialist of high standing for examination, and his written report stated that there was no pathologic condition present in either ear; that there was a gradual loss of hearing, due to sclerosis of the joints of the three little bones in the middle ear; that deafness was increasing as age was increasing, and that nothing could be done in the way of treatment of any kind which could give any permanent relief. The patient was then sent to have an audiometer test made, a standard audiometer apparatus being employed in a sound proof room. The report (Fig. 10) showed a loss of 56 per cent in the left ear and 57 per cent in the right ear.

In the following two weeks, artificial dentures were constructed and inserted and a new vertical dimension established changing the measurement from 59 to 72 mm., an increase of 13 mm. This amount of opening gave (Fig. 11) a rather strained appearance to the patient's face owing to the lengthening of the striated muscle fibers of the muscles of expression. However, it eliminated the severe backward thrust of the mandible, and when the patient left the office she was sent immediately to have the second audiometer test taken. This was on October 17. Figure 12 shows the report on that date. The left ear now shows a loss of only 12 per cent and the right of only 16 per cent. Thus, the left ear shows an improvement in hearing of 44 per cent and the right ear an improvement of 41 per cent. This was discussed with the aurist, who expressed great interest in the result and advised that audiometer readings be taken at frequent intervals in the months following to determine whether this change for the better was maintained or was merely a temporary condition.

A little over a month later, November 21 (Fig. 13), another audiometer test was taken to determine the status of the hearing at that time. The report shows that the left ear had improved to only 8 per cent loss of hearing and the right ear has maintained itself at 16 per cent loss. At the end of six months, April 16, 1935, another audiometer test (Fig. 14) showed a further improvement of the left ear, now only a 3 per cent loss of hearing. The right ear had improved to a 9 per cent loss of hearing. A photograph taken of the patient at this time (Fig. 15) shows that the strained appearance caused by the vertical opening has entirely disappeared, the lips have lengthened to a pleasing position and the deep folds and pouches of skin have been eliminated, the facial appearance being much improved. It is significant also that the heavy deposit of salivary calculus which continually formed on the previous dentures has been eliminated, this indicating that there is more tongue room and an increased efficiency in deglutition, and therefore more complete drainage of the oral cavity.

At the end of a year, another audiometer test was taken, October 2, 1935, and this report (Fig. 16) again shows improvement. The left ear now showed no loss of hearing, and the right ear maintained the level of 9 per cent loss of hearing. At the end of the second year, another audiometer test was made (November 9, 1936). This report (Fig. 17) shows that there has been a decrease in the efficiency of the ears, the left ear showing a loss of 14.6 per cent and the right ear 21.3 per cent. The vertical dimension was measured, and it was found that the over all measurement now was 67.5 mm., a loss of 4.5 mm., due to settling of the dentures and changes in the tissue base.

The dentures were rebased, the over all vertical dimension being restored to 72 mm. An

audiometer test taken at this time (March 17, 1937) (Fig. 18) indicates that the left ear had improved to 13 per cent loss and the right ear to 16 per cent; which, compared with the reading taken at the time the dentures were inserted, October 17, 1934 (Fig. 12) shows that the efficiency of the ears is practically the same as it was at that time.

This case is interesting because it shows the remarkable sensitiveness of the hearing to the position of the mandible, at least in this particular patient. It is the first case on record which shows the audiometer reports before and after the change in vertical dimension and which was followed up for a period of time to determine whether the increase in efficiency had been maintained. Only when this is done in a series of cases can the dental profession offer scientific proof of this phenomenon to the medical profession. How many patients today are being told by competent ear specialists that their hearing is gradually decreasing because of advancing age and little or nothing, from the aurist's point of view, can be done about it? The means of improving this situation is in dentistry's hands. The burden of proof is on us. When we can show, through continued research, the scientific evidence of the relation of lost vertical dimension to the organ of hearing, what a wonderful opportunity will be presented for cooperation by the aurist and the dentist!

Therefore, when a patient requires the construction of dentures or has a broken down natural occlusion, the dentist has a choice of two procedures: He may practice conformative dentistry, which means that he will take the path of least resistance and build a set of dentures to perpetuate whatever abnormalities the patient presents at the time, making no effort (1) to correct any deforming influences that may be at work in the temporomandibular joint, (2) to restore the mandible to its normal balanced position with proper distances between the origin and insertion of the muscles of mastication, the muscles of expression, and the pendant muscles of the mandible, (3) to increase the size of the mouth cavity to give the tongue more room and to improve the physiologic process of deglutition and (4) to restore the facial appearance to what it should be with a normal set of teeth, allowing shortened lips to guide him in determining the length of the bite; or he may practice corrective dentistry, and endeavor to correct the above-mentioned deformities, having in mind the norm and rebuilding the case as nearly to that ideal condition as possible.

1353 Lowry Medical Arts Building.

# GENERAL ANESTHESIA IN OFFICE PRACTICE

By George W. Christiansen, A.B., D.D.S., M.S., Detroit, Mich.

BY employing anesthesia to prevent pain in ministering to daily needs of practice, the dental profession contributes much to human comfort and happiness and simultaneously dispels a fear which is almost folklore.

Instruction in local anesthesia is widespread. There are many articles on technics, on solutions and on structures encountered by the needle. Elaborate charts and schematic drawings are distributed and demonstrations and table clinics to show the simplicity of its use are common. Such teaching naturally has improved the ability of many practitioners in the use of this procedure.

There is, however, a vast amount of work done under general anesthesia. A survey made several years ago[1] revealed the fact that in 60 per cent of all extractions, nitrous oxide-oxygen was the anesthetic used. For operations in children and in nervous adults, alveolectomy, incision and drainage of edematous masses, and for emergency surgery in acutely inflamed tissues, a substitute for general anesthesia has not been found. But, contrary to the instruction booklets, the successful administration of general anesthetics is difficult and requires training and broad experience. Unfortunately and unavoidably, dental curricula and most postgraduate courses offer little training in this work.

There are many legitimate reasons for this. One cannot demonstrate on anatomic specimens, alone, methods of obtaining and maintaining general anesthesia. Many more clinical facilities are required, such as patients and trained teachers, and the opportunity must be available for each student to practice the art. One may learn general anesthesia only by practical experience; observation is not enough. There are no regular, safe charted courses within whose limits results are uniformly successful. The beginner fails to observe important signals which are very evident to the trained anesthetist.

Good results in nitrous oxide-oxygen anesthesia require adequate equipment, a qualified anesthetist, preparation of and some examination of the patient and judgment in the selection of cases.

## EQUIPMENT

Ample equipment includes a machine in correct adjustment, sufficient gas, regardless of how long the case may progress, several sizes of the right kind of mouth prop, mouth gags strong enough to reopen the mouth if the prop is displaced, mouth packs of various sizes, restraining straps and a suitable aspirator. During anesthesia, situations change with amazing suddenness and it is wise to have available what is needed.

## ASSISTANCE

An able anesthetist means the difference between a good and a bad result. Maintaining anesthesia with the mouth wide open and uncovered presents an entirely different problem from the narcosis for general surgery, and for even fair success the mouth must be packed carefully. Even then, if the anesthetist is un-

(Read before the Section on Oral Surgery, Exodontia and Anesthesia at the Seventy-Ninth Annual Session of the American Dental Association, Atlantic City, N. J., July 14, 1937.)

familiar with the requirements of the work, the course may be stormy. A strong tendency to mouth-breathing is a common complication and must be overcome by increasing the pressure of the gases constantly by the left hand of the anesthetist. Failure to maintain anesthesia can result from poor adaption of the nasal inhaler when an operation is being performed under the upper lip, as in

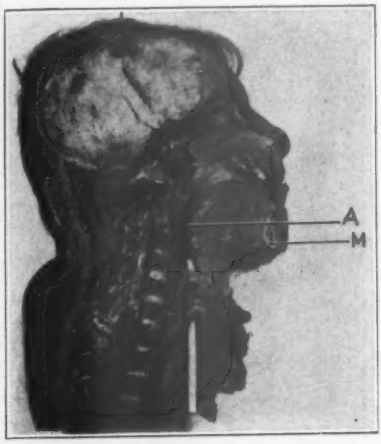



Fig. 1.—Airway (A) unobstructed by base of tongue. The mandible (M) is not depressed or swung laterally.

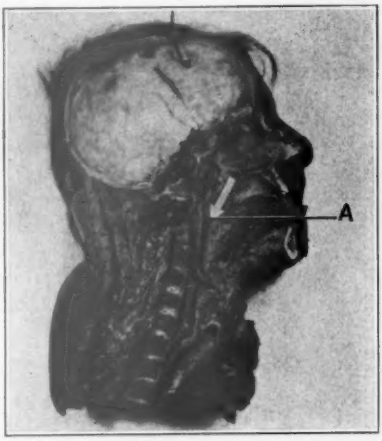



Fig. 3.—Peritonsillar edema elevating lateral pharyngeal wall to occlude with tongue at A.

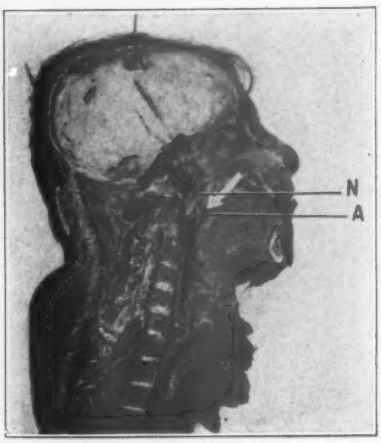



Fig. 2.—Edema in nasopharynx (N) forcing velum forward to reduce airway.

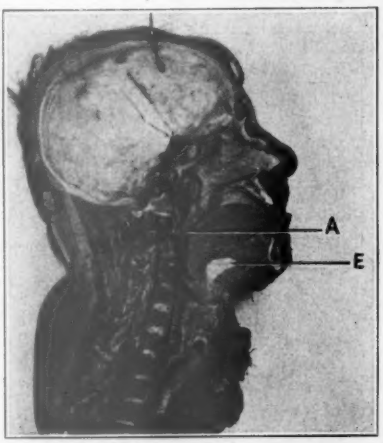



Fig. 4.—Edema (E), such as is seen in Ludwig's angina, elevating base of tongue to reduce airway at A.

as delivered. The tendency of the mandible to sag and to be depressed by the operator necessitates elevation of this shaping the process after the removal of upper anterior teeth. It is important that the inhaler constantly be tightly adapted

to the nose to prevent both the loss of the gaseous mixture and the intake of air.

EXAMINATION OF PATIENT

Mention is made of the hazard which exists in the indiscriminate use of nitrous oxide in office practice without a preliminary physical examination. In a sense, this warning is real and not sounded loudly enough; for if all who present themselves are accepted blindly and without question, surely there is an element of danger present. On the other hand, if judgment is used, this method offers a

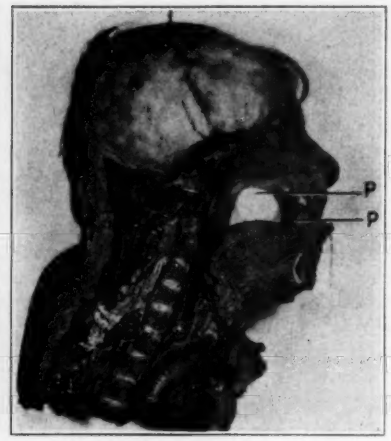



Fig. 5.—Mouth pack (P) in position against soft palate, with mouth prop (P, below) back as far as possible.

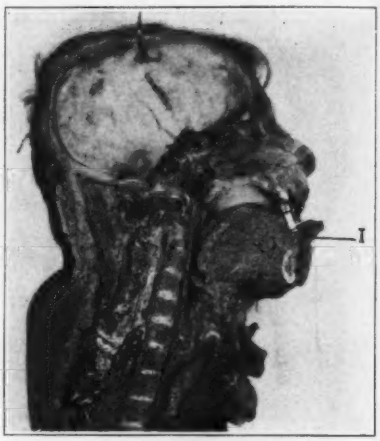



Fig. 7.—Mouth prop placed too far anteriorly. Heavy stress in this position can loosen incisor teeth (I) or the mandible can swing laterally or retrude.

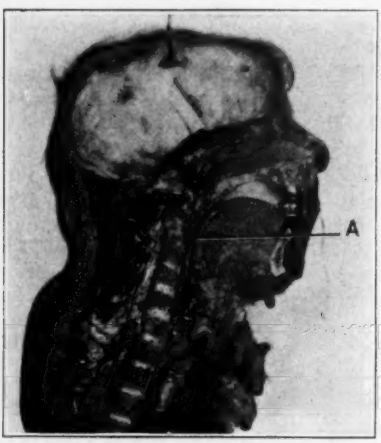



Fig. 6.—Mandible swung to right, with decrease of mouth opening and reduction of the airway at A.

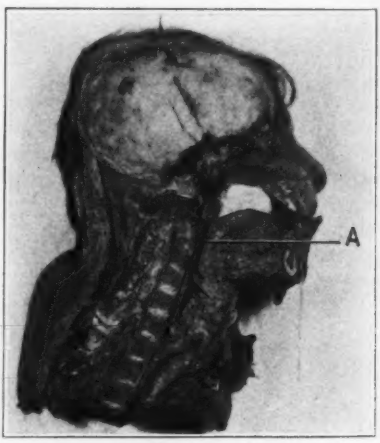



Fig. 8.—Displacement of mouth prop by closing of jaw, forcing gauze against tongue, which is driven back, reducing airway at A.

wide range of application and is without equal for most oral operations.

Patients who have had nitrous oxide usually wish to tell of their previous experiences, and those who have not should know what to expect. Therefore, before starting, the operator should sit down and talk with the patient a few minutes. During this conversation some information may be gained about the health of the patient, as regards any recent illness, chronic complaints, any disabilities present and perhaps a definite contraindication to general anesthesia. It is rare indeed for one to suffer for long from a grave disorder and not be conscious of it and, if cognizant, not to mention it when questioned. Such an inquiry sometimes reveals the

Fig. 9.—Tube passing through nose, nasopharynx (N) and oropharynx (O) into trachea (T).

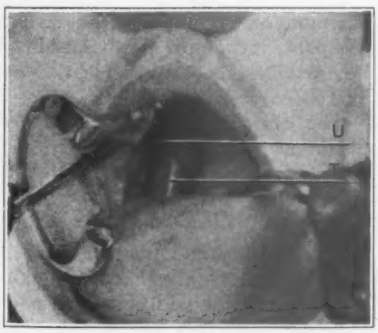



Fig. 10.—Velum lifted and base of tongue depressed to show endotracheal tube against pharyngeal wall. This method insures a free airway and permits tight packing of the oral pharynx.

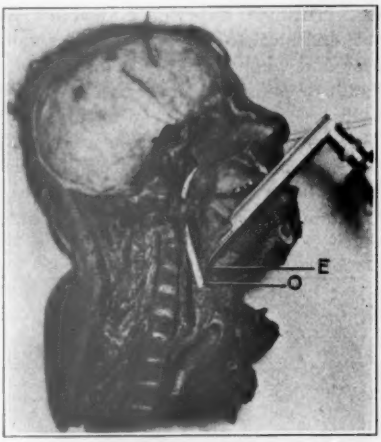



Fig. 11.—Laryngoscope depressing base of tongue and engaging epiglottis (E) to permit vision of laryngeal opening (O).

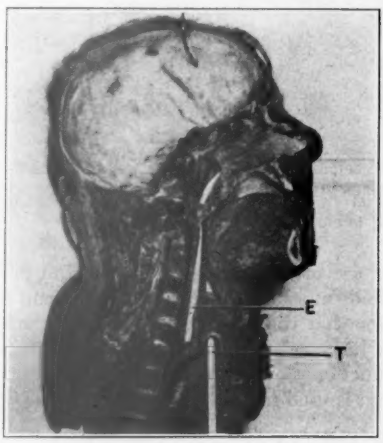



Fig. 12.—Tube passed over epiglottis to enter esophagus; probe in trachea (T).

presence of diabetes, alcoholism, shortness of breath in cardiac disease, anemia or hypertension, and incidentally gives one an opportunity to observe and look for abnormalities. Laboratory examination, however exact, cannot be substituted for keen scrutiny. Experience teaches us what conduct to expect from certain types; and when so recognized, a simple, difficult or perilous anesthesia can be expected.

However, the presence in a mild form of such an ailment as cardiovascular disease, diabetes, anemia, hyperthyroidism or asthma does not necessarily preclude

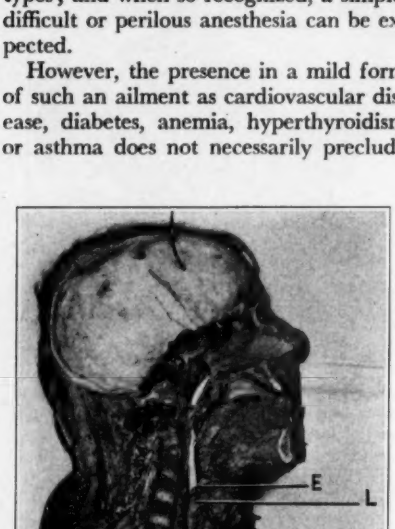



Fig. 13.—End of tube depressing epiglottis (E) to close opening to larynx (L).

the use of nitrous oxide-oxygen, but demands more cautious management and a somewhat different technic. In anemia, for instance, the anesthetist should begin induction slowly and with more oxygen than is used normally.

### CONDITIONS WHICH COMPLICATE ANESTHESIA

Swelling about the face and submaxillary region, particularly if associated with trismus, should be investigated carefully as to extent and character. (Fig. 1.) Extra-oral enlargement without localization may show pointing elsewhere. Frequently, edema invades the naso-pharynx or oropharynx and it may indicate a large localized abscess which will rupture when the mouth is opened wide or if the overlying tissues are manipulated roughly. This danger exists in postpharyngeal (Fig. 2), peritonsillar (Fig. 3), pterygomaxillary and mylohyoid (Fig. 4) involvements. Identification is often very difficult because the patient refuses even to try to open the mouth, but, regardless of the patient's attitude, a finger must be inserted and the critical areas palpated before induction is begun. The patient must not be subjected to the peril of aspirating pus from abscess drainage, with imminent lung abscess, nor of death from suffocation by having the asphyxiant pour into the trachea.

Just as the type of patient influences the anesthetic problem, so also does the type of operation. A deep mandibular impaction, the recovery of buried roots and procedures which cause bleeding into the nasal cavity all decrease the probability of smooth anesthesia. Short mandibles also increase the hazards. The difficulty of maintaining a properly functioning mouth pack, preventing postnasal bleeding or keeping the airway clear is increased here. Such difficulities can of course be overcome, but the anesthetist should know what usually happens and be prepared.

### KEEPING THE MOUTH OPEN

Because opening the mouth is difficult after the patient is anesthetized, a suitable mouth prop should be put in position before induction begins. A good prop will not collapse under pressure and should be placed well posteriorly on the side opposite that where work is to be done, preferably against an edentulous area back of the last tooth. (Fig. 5.) Proportionately as the prop is moved forward, the possibility of lateral movement of the jaw (Fig. 6) is increased, with con-

sequent greater danger of dislodging the prop and so increasing pressure on the tongue with the mouth pack. After the prop is put in the right position, we must see that it is not pushed forward by the tongue. Heavy stress against the lower incisors (Fig. 7) can injure their attachment.

Later, while operating, we should endeavor to avoid closure of the mouth, which will push the tongue backward by pressure on the pack. If the patient succeeds in displacing the prop and is allowed to close forcibly on the gauze (Fig. 8), breathing is impeded, with decrease of oxygen intake. A struggle for air begins, and if it is not obtained, respiration may stop.

To open the mouth under these circumstances requires much force with a powerful mouth gag, and this force, if directed against anterior teeth, may loosen or dislodge them. Such accidents are preventable if a prop of the right size is carefully placed and is then kept where it belongs. The ratchet type instrument is not very dependable because of the difficulty of keeping it in position, since, without both upper and lower teeth present, the beaks slip. In patients with short thick necks, opening the mouth very wide in the beginning is unwise, for if they are unable to breathe freely, induction may not be tranquil.

### MOUTHPACK

The dual purpose of the mouthpack to prevent mouth breathing and to protect the throat from foreign bodies is better understood than achieved. Because the usual attempt is poorly executed, the pack is ineffective, and when it fails to serve its purpose, poor anesthesia ensues.

In early anesthesia, the tongue is not relaxed and is higher than later, so that difficulty is sometimes met when the first pack is inserted. The pack should be pushed well backward to the velum with the ends extending over the occlusal surfaces of the lower teeth, and as the tongue pressure is eased, making more room, another pack is added. Leakage through the lateral vestibules of the mouth, that is, between the buccal surfaces of the teeth and the cheeks, is common and should be prevented by placing gauze there as the occasion demands. The first or primary pack stays in position, but the secondary packs are changed when saturated with blood and saliva. The necessity for constantly observing the condition of the barricade, of replacing wet packs and supplementing them with more material when necessary, cannot be overemphasized. Most of the so-called difficult cases are made so because the anesthetist does not receive proper cooperation from the surgeon in this matter. A small well-moistened slippery mass of gauze or cotton sliding about on the base of the tongue does not fulfil the requirements of a good mouthpack.

### THE CHAIR AND THE POSITION OF THE PATIENT

Because they are common knowledge, mere mention will be made of the following fundamentals. The chair used should have an easily operated but well-locked head-and-back rest to permit quick adjustment should the patient change position, but one that will resist pressure without yielding. The chair is tipped slightly backward and the headrest carefully adjusted, and male patients, after induction is started, are restrained. The patient, under ideal anesthesia, needs no suppression, but since the probabilities are that we shall fall short of this standard, provision must be made to keep him in the chair in the proper position. Fiber trunk straps are very useful for this, one strap around the pelvis and back of the chair and the other round the knees. Repeatedly and quietly reassuring the patient that all is well is very beneficial.

All unnecessary noise, such as conversation in an undertone and from persons moving about and opening and closing cabinet drawers, is disturbing and should

be avoided. Instrument selection and arrangement are made before administration of the anesthetic is begun, so that one is free to devote his entire attention to supervising induction. After even a few breaths, fear or a fancied sense of suffocation can cause a sudden violent commotion; in which case the anesthetist needs immediate assistance. If the surgeon is alert and attentive during early induction, the patient is assured that he is in capable hands.

Likewise, recovery should be watched as carefully to prevent injury to the patient who tries to stand, holds his breath or throws himself about when half awake.

### NASO-ENDOTRACHEAL INTUBATION

Naso-endotracheal intubation consists of passing a well-lubricated rubber catheter through the more open nostril, nasopharynx and oropharynx, past the epiglottis, between the chords, and into the trachea, transmitting anesthetic gases undiluted to their destination (Fig. 9). The principle is excellent and the result is as practical as described, but the drawback is the occasional difficulty encountered in inserting the tube (Fig. 10).

There are two methods, the direct and indirect. The former is tried first, as follows: After surgical anesthesia is obtained, the mouth and other nostril are closed while an attempt is made to put the tube in place. If the effort is successful, the characteristic bronchial breath sounds will be heard, and tubal ventilation will be evident, but if the operator is unsuccessful after several trials, a laryngoscope is used to pull the tongue and epiglottis forward to expose the larynx (Fig. 11). During this time, the degree of anesthesia decreases, and the former level must be reestablished before efforts at insertion are again made.

Indications for endotracheal anesthesia, which unfortunately complicate insertion of the catheter, are: upper respiratory obstructions, particularly nasal, difficulty in maintaining anesthesia and the need for an especially tight mouth pack.

Obstructions increase the difficulty of directing the tube and a few breaths of air can check anesthesia and a struggle result.

The tube, in failing to enter the trachea, may slide over the epiglottis into the esophagus (Fig. 12), or it may depress the epiglottis to close the laryngeal opening (Fig. 13).

### ANOXEMIA

Recent studies of brain substance at necropsy in deaths from anesthesia have shown cellular damage attributable to oxygen want, for which the anesthestic agent has been blamed.

Since anoxemia is the injurious factor in all asphyxia and is produced by diminishing the oxygen intake either by mechanical or other means, the charge that nitrous oxide-oxygen *per se* is responsible has no logical basis. Raginsky and Bourne,[2] in their work "The Oxygen Content of Blood During Nitrous Oxide-Oxygen Anesthesia in Man," say:

> Interpretation of the significance of the oxygen content of arterial blood during anesthesia must of necessity take into consideration factors apart from the administration of the anesthetic which, in themselves, may produce a lowering of the arterial oxygen content. Any mechanical obstruction of the respiratory passages tends to reduce the oxygen supply. This is a very important factor in dental operations involving operative procedures which cause a certain degree of respiratory obstruction. Saliva and blood in the mouth and throat interfere with the free passage of the anesthetic mixture into the lungs and the removal of the products of respiration outwards.

Therefore, it would seem that the cerebral injury found is the result of an insufficiency of oxygen, a condition which may result from any procedure which impedes breathing, thereby depriving the tissues of enough oxygen for satisfactory metabolism. Thus, the asphyxia from carbon monoxide poisoning or from poor

anesthesia produces a similar condition.

### CONCLUSIONS

Under nitrous oxide-oxygen anesthesia skilfully used, which implies judgment in its application, narcosis closely approaches the ideal for some kinds of mouth surgery. What else offers escape for the terror stricken patient whose imagination has magnified her problem to the dimensions of a calamity? Because the mental trauma from worry, by its persistence, has a devastating effect on the patient's future attitude for similar procedures, pain and fright must be avoided. We do wrong when, because of personal incompetence or lack of facilities, we urge the use of local anesthesia when we know that general anesthesia is indicated.

Before condemning nitrous oxide-oxygen, the safety and danger elements should be honestly evaluated. Security for the patient in general anesthesia is in direct proportion to the skill and ability employed in its application. Conversely, the peril increases with a lack of this.

### BIBLIOGRAPHY

1. McKesson, E. I.: Essentials of Nitrous Oxid-Oxygen Anesthesia with a Review of Its Use in America, J.A.D.A., 13:411, April 1926.
2. Raginsky, B. B., and Bourne, Wesley: *Canad. M. A. J.*, 30:518, May 1934.

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# ORAL SURGERY AND RADIATION THERAPY IN TUMORS OF THE MOUTH

By Douglas Quick, M.B. (Tor.), F.A.C.S., F.A.C.R., New York City

IT is not the purpose of this paper to attempt a division of the many and varied tumors of the mouth into two groups, one for treatment by operative surgery and the other for treatment by radiation. On the contrary, it is a very earnest plea for the closest cooperative use of the two methods in dealing with most intra-oral tumors or growths. The method is not new: it has been advocated and practised for twenty years and consequently has an experience background which well warrants its continuance and more general application. It is only by constant repetition that this can be established.

The fact that the handling of intra-oral tumors is a surgical problem does not imply the use of essentially operative surgery; nor does this imply complete control of some tumors by the pure radiologist. It does mean either complete control or full responsibility by one experienced in both branches or full and intimate cooperation from beginning to end by oral surgeon and radiologist. It aims strictly at avoidance of a shift of management from one to the other with a distinct break or gap between, after whichever specialty has had first chance and indulged its facilities to the limit before seeking assistance. The best interests of the patients are usually sacrificed and often irreparably damaged by such procedure.

The first essential for treatment of any tumor or ulcerating lesion of the mouth is accurate diagnosis. It is not the purpose to go into this in detail, nor does time permit of doing so. However, it must be remarked that tissue biopsy at an early date is usually most valuable and rarely

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out of order. Bacterial cultures have a very limited application. The positive Wassermann or Kahn reaction may serve only to cover up a more serious condition if depended on too fully. X-ray films, while essential and of extreme value in tumors of the bony parts, have their limitations. I have recently seen a recurrent tumor of the mandible, operated on originally by a dependable oral surgeon and carrying a diagnosis from that operation of adamantinoma—section not available for review. The clinical history and roentgenograms supported this diagnosis, and yet a biopsy specimen showed it to be a giant-cell tumor.

This accurate information obtained on biopsy resulted in a distinct shift in both treatment program and prognosis.

A superficial consideration might at once relegate all inflammatory tumors to operative surgery or suitable medication. (I have in mind such tumors as the benign giant-cell epulis, dentigerous cyst and specific granulomata.) As a rule, this is true, yet not always. Some benign tumors—certain of the more aggressive epulides and localized angiomata—are, on account of their extreme vascularity, rendered more operable, or eradicated entirely, by preliminary irradiation. Some of the granulomata, notably the lesions of actinomycosis, respond very satisfactorily to irradiation.

No matter how obviously benign a tumor of the mouth may be, its removal should always be approached with the utmost care and precision. Unnecessary distortion of the soft parts may leave the patient with simple, but aggravating symptoms. It may interfere with subsequent restoration. Where adherence to periosteum is encountered, at least an instant's consideration should be given to the possible value of our present-day nicely regulated high-frequency cauteries as an additional aid. If pressure erosion or invasion of bone calls for the use of a curet, it should be used thoroughly, but at the same time methodically and accurately. There is a distinct difference between curetting bone and "scraping" bone. The difference is trauma. Finally, all tumors demand histologic examination. They should be deposited in the pathologic laboratory, not the waste receptacle.

When it comes to dealing with malignant neoplasms of the mouth, irradiation therapy enters and takes precedence over all other methods. Irradiation means the application of either radium or the x-rays or of both. There is no controversy or competition, other than the factor of quality, between the two agents as sources of therapeutic radiant energy. The former is for external application over localized areas or, more important, for implantation in some form within tissues. The latter is adapted to external application only, and is readily available in any quantity consistent with tolerance of the extra-tumoral normal tissues.

Control of growth should always be dependent directly on irradiation and should be most aggressive. Operative surgery is essential and of greatest value in many instances as an aid, but practically never for the anticipated cure *per se* of a malignant neoplasm. The extensive and excellent radical surgery of the period preceding the irradiation era gave ample proof of the need for further aid. Much of this discouraging surgery was very mutilating. The surgery called for today in combination with irradiation is much more conservative, less mutilating, less shocking, and hence usually tolerated in many cases otherwise regarded as poor surgical risks in the general acceptance of that term. It resolves into three main uses, for (1) access to tumor bearing areas, (2) drainage and (3) removal of postirradiated tissues liable to gross necrosis following adequate irradiation for growth control.

In order to avoid disappointment, irradiation must be carried out with the same attention to detail and nicely adjusted technical procedure that is recognized as essential in operative surgery. If

an operative procedure is necessary to facilitate accurate and uniform radium application, it becomes an essential part of the treatment program. A normal reaction to irradiation is never obtainable in the presence of uncontrolled infection, which only tends to enhance the rate and spread of tumor growth. Various operative procedures must therefore be resorted to in order that drainage shall at all times be free. In this connection, the high-frequency bipolar cutting cautery is usually superior to either sharp dissection or the thermo-electric cautery.

Under certain circumstances, the tumor bed may be of abnormal structure and therefore more liable to necrosis under the influence of heavy irradiation than an otherwise normal tumor bed. The scar tissue and altered or decreased blood vascular apparatus of recurrent disease or inadequately treated cancer afford an excellent example. Practically the same situation is met with in cancer of the tongue which has undergone the changes of a syphilitic glossitis. Bone frequently presents a similar problem. The blood supply is always meager and hence cannot be depended on for aid in irradiation to the same degree as the rich capillary network of soft parts. A secondary problem of osteomyelitis is always associated with direct tumor invasion of bone. (Please note that there is here a distinct difference between tumor of soft parts secondarily invading bone, and primary bone tumor with its layers of cells tending to ward off infection.) Under circumstances such as these just enumerated, namely, unusual infection in soft tissues or bone or soft tissues discounted by previous treatment, operative or radiation, it is frequently wiser to remove the area of gross involvement by cautery or by the usual surgical measures rather than risk gross necrosis from the irradiation which has been necessary to control the growth.

Surgical procedures such as these are rarely mutilating to the same degree as are operative procedures designed for direct cure of the disease; they are never so in the so-called operable stage of cancer. The combination of surgery and irradiation in this manner obviously embraces a much larger group of cases than does the most optimistic surgery alone.

Decision as to the combination and sequence of the various procedures in any treatment program are obviously dependent on many factors. The histologic examination is probably the chief guiding factor. It at once distinguishes between the tumor locally malignant only and the more dangerous types in which metastases must be anticipated. While histologic tumor grade and relative radiosensitivity are not parallel, there is at least a close relationship. Hence, the intensity of irradiation, the need or otherwise of some type of implantation in addition to external therapy and some inkling at least of prognosis can be determined and the plan of therapy for the individual case governed accordingly.

Other factors of influence in selection of the treatment combination are location and size of the tumor, degree of infection, if any, the general condition of patient and the presence, or absence, as well as the extent of metastases.

In the case that is very advanced either locally or by reason of widespread metastases, external therapy with x-rays as a palliative is obviously all that is indicated. As a matter of fact, external irradiation with high voltage x-rays, at long distance and heavily filtered, given at a slow rate and by frequent individual exposures, usually daily, represents the first step and backbone of treatment in practically every case of intra-oral cancer accepted for treatment. The influence of infection on reaction to irradiation has already been noted; hence, rigid oral hygiene is necessary at all times. A large tumor does not respond so well, other factors being comparable, as a smaller one because of the central interference with blood supply and liability to central necrosis, as well as to the greater quantity of radiant energy

called for. Relationship to vital structures may hamper either intensity or method of application of radium or prevent certain surgical procedures otherwise indicated. Constitutional disease is obviously a deterrent always. Anemia in any of its forms always hampers and often precludes an otherwise indicated combination of procedures. It should always be anticipated and prevented or combated by aggressive medical measures.

In any distinct group of tumors, the fully differentiated adult type or so-called histologic Grade I growth is relatively, for that group, most resistant to irradiation. It may call for external therapy, implantation and possibly some surgery. However, a result obtained with this type means more in anticipation of permanence than in the much more spectacular anaplastic grade III or IV, which melts away rapidly under external therapy alone. The former is far less liable to metastasize locally or at a distance; whereas the latter is ever apt to show up in almost any part or organ, as spectacularly as it disappeared locally, and furthermore is prone to disseminate through both lymphatics and the blood stream. To subject the patient to more than external irradiation is therefore scarcely indicated under such uncertainty as is evident in this type of histologic picture. This wide range of histologic variation is most frequently met with in that large group of malignant growths making up the great majority of intra-oral cancers, the epidermoid carcinomata. They present not only a complicated treatment problem dependent on many factors and a combination of measures both surgical and of irradiation just enumerated, but a secondary and equally important problem as well. This secondary problem is that of the metastatic cervical nodes. The management of the latter problem calls for the same combination of measures as in dealing with the primary growth and is governed by the same guiding factors.

One subgroup only of the epidermoid carcinomata rarely or never metastasizes; namely, those of basal-cell origin. Obviously, complete surgical removal or local radiation with radium is adequate for their care.

One tumor not infrequently met with about the jaws and debatably neoplastic deserves special mention because of the rather unusual response to external irradiation alone: the true giant-cell tumor of the mandible or maxillae. Although the response to external irradiation of moderate intensity is not so spectacular as with this type of tumor in the long bones of the extremities, it is nevertheless well worthy of note. Surgery is usually contraindicated.

Another malignant tumor of epithelial origin deserves special mention from the standpoint of this paper; namely, that arising from the enamel organ, the adamantinoma. For this lesion to be adequately dealt with by surgery alone, nothing short of jaw resection is sufficient. Such a procedure is disfiguring and is doubly distressing because the tumor, being of developmental origin, is almost invariably one of childhood or early adult life. Accumulating experience suggests that it may be successfully managed by heavy prolonged external irradiation, followed by a conservative intra-oral operation and finally surface application of heavily filtered radium from within.

It has not been possible within the scope of this paper to go into technical detail in any particular. The effort has been aimed entirely toward emphasizing the need for combining surgery and irradiation in every way possible if we are to make headway in the treatment of the varied groups of tumors, chiefly the malignant tumors, met with in the mouth. The ultimate curability ratio is such that any open-minded view must embrace every available and worthwhile facility which has been proved of value in increasing curability.

# AMALGAM: THE NECESSITY FOR CONSIDERATION OF ITS PHYSICAL PROPERTIES AND A PRACTICAL TECHNIC

By Ernest E. Cannon, D.D.S., La Crescenta, Calif.

AMALGAM, since its introduction to dentistry over a century ago, has been the subject of many bitter controversies. Much of the prejudice against its use was eliminated, however, as a result of the scientific work of such men as Flagg, Palmer, Chase and G. V. Black. For a long period before the gold inlay became popular, it was the only filling material, except gold foil, that could be considered permanent for use in the posterior teeth.

The perfection of the gold inlay, if it is permissible to say that it has been perfected, resulted in amalgam being relegated to the near vanishing point in many practices. This seems to have been particularly true in the larger centers of population and during the period of greatest prosperity.

### REASONS FOR INCREASED USE OF AMALGAM

At the present time, the pendulum swings back and the use of amalgam is increasing. There are a number of reasons for this situation, among which are: 1. Economic considerations. 2. The high percentage of gold inlay failures. 3. The improvement in silver alloys. 4. The limitations of gold foil.

*Economic Considerations.*—Unfortunately, many people who need and apply for dental service are able to pay only a minimum fee. These people must have a serviceable type of work and at a lower cost than is economically possible with gold. Amalgam fillings may be the logical answer, but not the quality of amalgam fillings that have been all too common in the past. Good amalgam restorations require time, but what individual tooth restoration service that is good can be rendered without the expenditure of time, as well as effort and skill? However, considerably less time is required for amalgam work than for the gold inlay.

*High Percentage of Inlay Failures.*—It is no secret that many of the best inlay operators are disappointed in that too many of their inlays fail prematurely. Such being the case, what about the so-called average inlays? It is hard to admit, but quite obvious, that such average inlays are not saving teeth. No doubt, the larger percentage of failures are due directly to improper cavity forms and imperfect marginal adaptation of the casting; and indirectly to the inadequate cementing medium used. The first two, namely, cavity forms and marginal adaptation can, to a considerable extent, be controlled by the skilled operator. It is obvious, too, that the soluble cementing medium can, to a large degree, be controlled in ratio to marginal adaptation. When we consider the high degree of technical skill and the conscientious painstaking attention to detail required to obtain proper cavity form and marginal adaptation of inlays, perhaps we

(Read before the Section on Operative Dentistry, Materia Medica and Therapeutics at the Seventy-Ninth Annual Session of the American Dental Association, Atlantic City, July 14, 1937.)

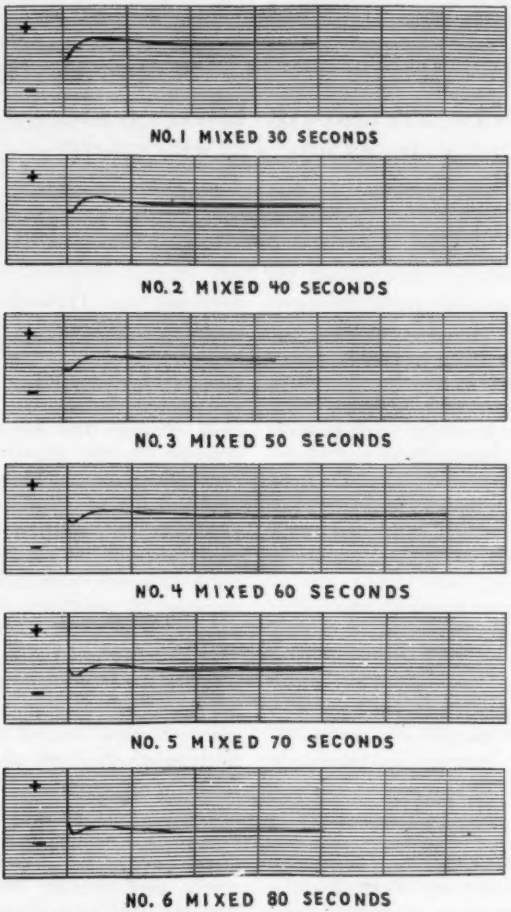
+
−
NO. 1 MIXED 30 SECONDS
NO. 2 MIXED 40 SECONDS
NO. 3 MIXED 50 SECONDS
NO. 4 MIXED 60 SECONDS
NO. 5 MIXED 70 SECONDS
NO. 6 MIXED 80 SECONDS

**Fig. 1.—Graph used with those that follow to call attention to volume effects of varying the triturating period of a given alloy. The tests are started on the heavy horizontal line. Each space above this base line indicates one micron of expansion; each space below indicates one micron of contraction. Each space between the perpendicular lines represents a period of six hours. For the specimen here tested, there was a small amount of initial contraction and rapid recovery resulted to and above the base line. As indicated, the amalgamating time for this particular alloy would be between thirty and forty seconds. Over fifty seconds would probably result in a permanently contracted filling. (The graphs and drawings herewith reproduced were furnished through the courtesy of George M. Hollenback, of Los Angeles; original drawings by Henry A. Linek, of the dental department of The University of Southern California.)**

have the answer, in part at least, to the high percentage of gold inlay failures.

*Improved Silver Alloys.*—The better manufacturers have improved their alloys. These improvements were due, in a large measure, directly to the research work of the Bureau of Standards and the Research Department of the American Dental Association; and indirectly to the help and inspiration given these groups

by individual members of the profession. The manufacturers deserve much credit for their cooperation and efforts. They themselves are, in some instances, well equipped and qualified for scientific research. It is not at all unreasonable to expect that better alloys than we now have can and will be produced.

*Limitations of Gold Foil.*—There is no doubt that gold foil in the hands of the skilled operator is the best tooth filling material available. There are, however, positions in the mouth and extensively broken down teeth where the application of gold foil is impossible or impractical. Then, too, the experience and skill necessary for extensive and difficult restorations, and economic considerations limit its field of application.

### AMALGAM IN MODERN DENTISTRY

Statements to the effect that amalgams occupy a place next in value to gold foil as a tooth-saving material are not uncommon. I refer to statements made by men in the profession who are qualified to speak with authority. Such statements, however, are not prompted by the predominating quality of the amalgam work done during the past fifty years, but rather by the quality of service that can be and is being rendered through the medium of the improved alloys now available, when properly used. Proper cavity

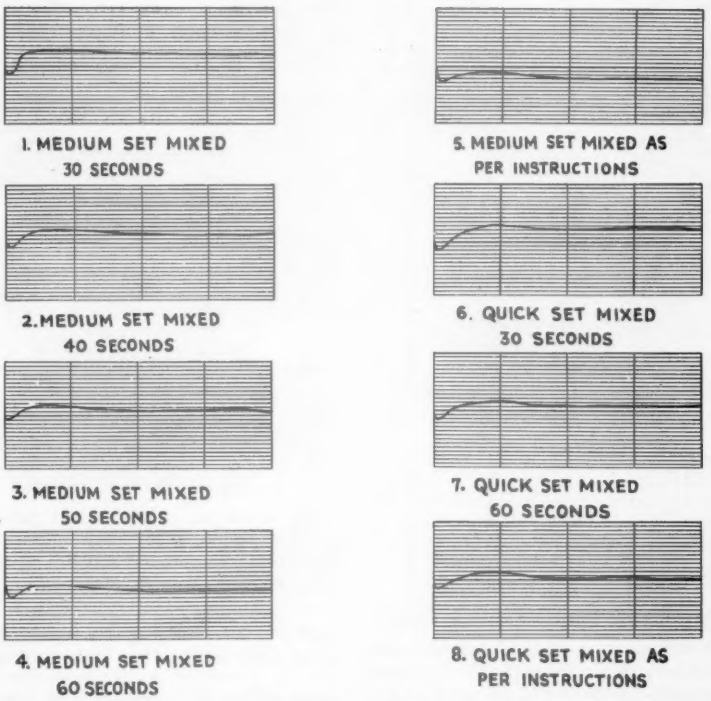
1. MEDIUM SET MIXED 30 SECONDS
2. MEDIUM SET MIXED 40 SECONDS
3. MEDIUM SET MIXED 50 SECONDS
4. MEDIUM SET MIXED 60 SECONDS
5. MEDIUM SET MIXED AS PER INSTRUCTIONS
6. QUICK SET MIXED 30 SECONDS
7. QUICK SET MIXED 60 SECONDS
8. QUICK SET MIXED AS PER INSTRUCTIONS

Fig. 2.—Alloy mixing, the period for which would be thirty or forty seconds for both medium and quick setting. Should the manufacturer's instructions be followed, a filling inserted from the medium set alloy would shrink excessively and one from the quick set would be near the danger line.

forms, an understanding of certain physical properties of amalgam and the employment of an efficient and carefully executed technic are absolute essentials to its most effective use.

In order to raise the standard of amalgam work, some education, or rather reeducation, is necessary. This applies to both the profession and the laity. By implication and otherwise, the laity generally have been given the impression, by the dentists themselves, that an amalgam filling is at best a very poor filling. Such

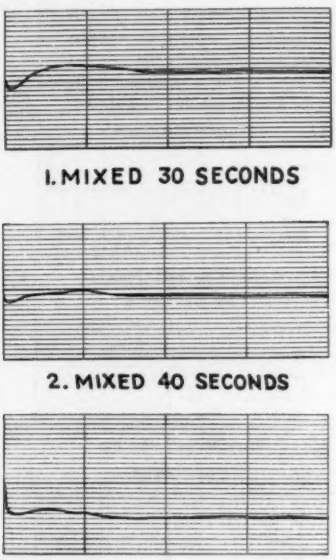


Fig. 3.—Alloy mixing, the period for which would be very short. Evidently, forty seconds would produce a contracted filling. This material would be unfit for use when mixed according to the manufacturer's instructions.

an impression will of necessity have to be changed; otherwise, the service rendered through the medium of amalgam will not be appreciated sufficiently to make it economically possible for the dentist to produce restorations of high quality.

As to reeducating the dentist, it is hardly logical to expect a high quality service through the use of amalgam or any other material without the proper understanding on his part of certain physical properties of such materials and the necessary technical knowledge for their most effective use.

We can generally agree that only a very small percentage of amalgam fillings afford evidence of more than mediocre skill. Yet many of these same fillings have been in service for many years.

If the profession as a whole would take amalgam work seriously, would it not be reasonable to expect that the appallingly high percentage of individual

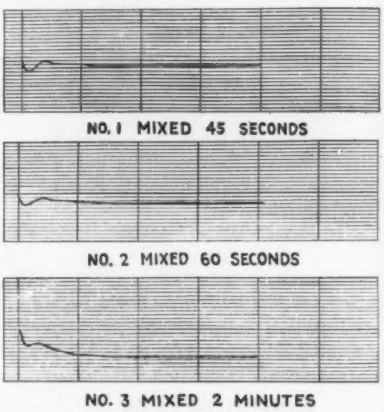


Fig. 4.—Brand of alloy which has been in popular use for many years. The effect of mixes of 45, 60 and 120 seconds, all of which show shrinkage, is to be noted.

tooth restoration failures would be very materially reduced?

### THE PHYSICAL PROPERTIES OF AMALGAM

Granting that the manufacturers have given us properly balanced alloys, we may assume that the amalgam produced therefrom will have sufficient crushing and edge strength, proper color and a minimum of undesirable volume changes, if properly handled, during the time it is being amalgamated and placed in the cavity.

We are told by scientific research work-

ers that to intelligently make a balanced amalgam, if it is permissible to use such a term as balanced amalgam, it is essential for the dentist to be familiar with certain of the physical properties of amalgam, as far as they are affected by the manipulative procedures used. We must bear in mind that the dentist, not the manufacturer, makes the amalgam.

With well-balanced alloys at our disposal, we are, therefore, particularly concerned regarding the physical properties of the amalgams as affected by the manipulative procedures employed in amalgamating these alloys and in filling the cavity.

I refer you to an excellent treatise on

Fig. 5.—Boxlike forms used in all preparations. (See also Figures 6-8.) A definite retentive form is made in all axial surface sections of compound cavities by slight extension of the axial wall into each surrounding wall. Angle formers and marginal trimmers are used for the purpose. To avoid undercutting enamel rods, extreme care should be taken in cutting the walls of axial surface cavities. The angle formed by the cavity wall and the surface of the tooth should be a slightly obtuse angle. The surface of the completed filling would then form an angle slightly under a right angle to that wall. This same principle should be observed in determining the direction of the cavity margin when extending an axial surface cavity into the occlusal surface. (See Fig. 13.)

"Effects of Variations in Manipulations on Dimensional Changes, Crushing Strength and Flow of Amalgams" by Ward and Scott.[1]

George M. Hollenback's recent scientific studies on amalgams are of particular value and interest in that they deal specifically with physical properties over which the operator has control, to a considerable degree, at least. I quote Dr. Hollenback[2] regarding certain of the physical properties of amalgam as affected by manipulation. His tests to determine the proper mixing time of a given alloy cover most of the popular alloys on the market.

The first test is made by triturating the mix until it becomes plastic, using a pressure of from 2 to 3 pounds on the pestle, which is held with a pen grip, with approximately 150 revolutions of the pestle per minute. With many alloys, satisfactory plasticity can be se-

Fig. 6.—Conservation of the oblique ridge in this upper molar and of the transverse ridge in the mesioclusal preparation of a lower first bicuspid (Fig. 5) is to be noted.

cured in thirty seconds. The amalgam is then removed from the mortar, placed in a small piece of rubber dam and worked into a compact mass, hand mulling being omitted, except in tests made according to instructions of the manufacturers that call for it.

The method of packing the dies, removing excess mercury, mixing, etc., and placing in the recording micrometer were the same for all alloys tested. Again, quoting Dr. Hollenback[2]:

Each succeeding test is made by adding ten seconds to the mixing time, no other detail being changed in the slightest degree. Tests are made until the alloy is broken down, ulti-

mately showing shrinkage. It will be readily understood that the mixing time will be established for each alloy; that is, which one gives the most desirable results will be determined. For instance, if desired, an ultimate expansion of 3 microns can be easily obtained, provided the given alloy has that wide an expansion range. In fact, any volume change within the range of the alloy may be secured.

Dr. Hollenback thus determines the triturating time of a given alloy. Before making the final tests on the various alloys, he noted the volume change brought about by certain other phases of the manipulative procedures, such as, for instance, the pressure applied with the pestle and the number of revolutions of the pestle per minute; and the effect of

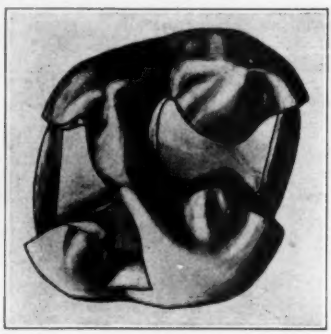

Fig. 7.—Occlusal view of preparations in Figure 6.

using certain types of mortars and pestles. He thus worked out a standardized method of procedure in the tests just described. As to the time required for amalgamation, Dr. Hollenback[3] writes:

Trituration should be maintained until the mass becomes smooth and plastic, presenting a bright surface. This is a safe procedure with most alloys, but there is at least one on the market that requires a great deal more trituration to prevent excessive expansion. The time required will be from thirty seconds to nearly two minutes, depending on the alloy used.

It would seem, judging from the tests just described, that many writers on amalgam have in the past advised too long a mixing period for amalgamation. In fact, a given mixing period was often indicated as applicable to any and all alloys. It is quite likely that fillings made from many alloys thus amalgamated shrink so excessively and without recovery that marginal leakage of the filling is the inevitable result.

It is to be hoped that a method will be discovered for preventing altogether the usual initial shrinkage of an amalgam, at the same time retaining the desired minimum amount of expansion.

## TECHNIC*

*Preparation.*—Instruments and materials should be ready and in order, that the work may proceed without interruption. This is particularly important from

Fig. 8.—Reduction of an undermined cusp. Allowance must here be made for an adequate bulk of filling material for occlusal stresses.

the moment the amalgamation of the alloy is complete. A set of amalgam condensers with working points of sizes and shapes to readily reach every angle and section of the cavity is selected. This is important. Amalgam will go only where definitely placed.

The assistant should be trained to amalgamate the alloy, to express the excess mercury from each piece at just the moment it is to be used and to pass the

*The technic herein described is that taught in the amalgam classes, Division of Education Courses, Southern California State Dental Association. Except for a few minor changes or additions, it was originally suggested by Dr. Hollenback.

amalgam to the cavity as required by the operator. The whole procedure should be so timed as to facilitate the insertion of the filling in the minimum length of time.

*The Rubber Dam.*—Where possible, the rubber dam should be used during the cavity preparation and the filling operation. Its use promotes better and safer dentistry. The following quotation from Edward H. Hatton[4] on "Pulp Pathology from the Standpoint of the Clinician" is food for thought:

> The susceptibility of the dentin arises from its relatively porous character, penetrated as it is with minute tubules, and from the structural character of these tubules. The structure and function of the soft tissue extensions of the odontoblasts, Tomes' fibers, contained within these tubules, are not only susceptible to the effect of injury, but these structures serve equally well to transmit injury to the pulp. . . . Therefore, as soon as the dentin is exposed in any fashion whatever, degenerative and retrograde changes are set up in these tubular contents, that is, Tomes' fibers. This is not only what should be expected, but it is also capable of ready demonstration by histologic and experimental methods. Even diffusible chemicals, if deposited on denuded dentin, are carried not only to the pulp, but even to remote parts of the body as long as the tubules contain soft tissues or retain their porous character.

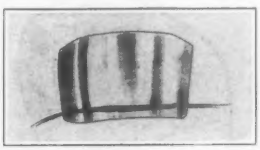

Fig. 9.—Prepared matrix, with ligature in place, for a simple proximal cavity. Polished stainless steel two thousandths inch in thickness is recommended for the purpose.

*Cavity Forms.*—A cavity intended to receive an amalgam filling should be as carefully and skilfully prepared as one to be filled with gold. The generally recognized principles of cavity preparation should be observed, except for slight variations due to the nature of the material. Provision should be made for a sufficient bulk of material to withstand the stresses to which the filling will be subjected. For proximal cavities, the buccal and lingual margins of the occlusal extensions should approach the proximal surface of the tooth at approximately a right angle to that surface, this providing for an adequate bulk of material at the junction of the proximal and occlusal surfaces of the filling at those margins. The proximal section of a cavity should be made retentive by slightly undercutting the buccal and lingual walls at their junction with the axial wall and by grooving the gingival wall at its junction with the axial wall, these retentive cuts being in dentin. Cavity margins are not beveled.

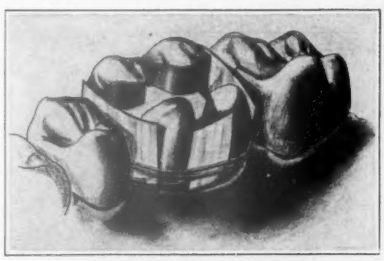

Fig. 10.—Matrices ligated to position for a mesioclusodistolingual preparation. When round toothpick wedges are used, the ligature need be passed but once around the tooth.

*Cavity Sterilization.*—Because of the permeability of dentin, it is considered all the more imperative that the exposed dentin be sterilized and the tubules sealed with a varnish or covered with cement where a base is indicated.

In deep-seated cavities, many operators believe that there is no agent more effective than the application of ammoniacal silver nitrate followed by a precipitating agent such as eugenol, before placing a cement base, or on any dentin surface where the discoloration would not be in evidence when the restoration is completed.

*The Matrix.*—Highly polished stainless

steel bands, two thousandths inch in thickness, cut on an arc, are used for matrices. The diameter of the circle formed by the arc-shaped bands is shorter at the edge placed gingivally, "flaring" of the matrix toward the adjacent tooth resulting. For a proximal lower molar cavity, for instance, the matrix is cut sufficiently long to lap about 3 mm. over the buccal and lingual margins of the cavity and wide enough to extend 1 mm. below the gingival margin and about 1 mm. above the occlusal surface of the tooth. A hole is punched at each end of the matrix at a point just short of the ends and just short of the gingival edge. With the matrix in position, these holes would extend buccally and lingually to the corresponding cavity margins. A

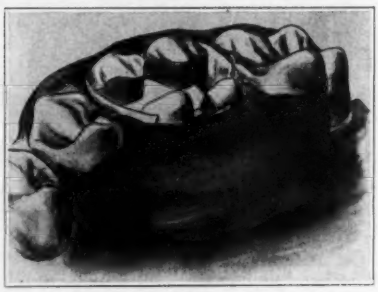

Fig. 11.—Tooth shown in Figure 10, with modeling compound support of the matrices. Instead of sticking the compound to the adjoining teeth as shown here, the operator may use small metal retainers or a rubber dam clamp to support the modeling compound. The latter methods are described in the text under the heading "The matrix."

piece of dental floss is threaded through the holes, and the matrix bent sufficiently to conform to the tooth and with enough tension to spring the matrix to contact with the cavity margins. With the matrix in position, it is now wedged against the gingival margin of the cavity with a short section of a round toothpick. The floss engaging the matrix is carried around the tooth and ligated to place.

Those proximal cavities which are narrow enough buccolingually to permit of complete adaptation of the matrix at the gingival margin with the toothpick wedge need not be tied to the tooth. In such cases, it is not necessary to punch holes in the matrix or use dental floss.

The matrix is held in position and supported by modeling compound. This should be done in such a manner as to permit freedom of movement of the tooth or teeth proximating the cavity in order to secure adequate separation for contact points. The separation is secured by the pressure applied against the matrix in condensing the amalgam, this pressure being transmitted to the proximating tooth or teeth. The round toothpick wedge used for wedging the matrix against the gingival margin of the cavity is also a factor.

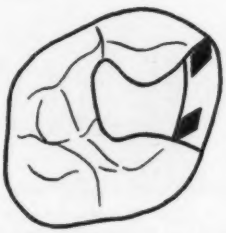

Fig. 12.—Adaptability of diamond-shaped condensing point in angles and undercuts in axial surface extensions of compound cavities.

The modeling compound support of the matrix is secured in the following manner: The buccal and lingual surfaces of the tooth to be filled are wiped with chloroform. A lubricant is applied to the proximating surfaces of the adjoining teeth to prevent the compound from sticking to these teeth. The end of a stick of green modeling compound is warmed and a piece the size of an ordinary lead pencil eraser is pinched off. Held with the thumb and finger, one end of this piece of compound is softened in a flame. With this sticky compound, the matrix is forced to close contact with the cavity margin, buccal or lingual, as the case may

be, and in such a manner that the compound will be forced against, and will stick to, the surface of the tooth to be filled; into the interproximal space, and against the lubricated surfaces of the tooth adjoining. The matrix is then adjusted for proper contour and contact position and the process of adapting it with the sticky compound to the other cavity margin is repeated. The first piece of compound should be applied to the surface from which the round toothpick wedge was inserted; otherwise, the wedge may be loosened.

Corrections are made by warming the compound with a heated instrument at the point desired and remolding with a cold instrument.

If a rubber dam clamp is on the tooth

Fig. 13.—Direction of buccal and lingual walls in relation to the proximal surface, as they pass through marginal ridge. The angle at B formed by tooth structure should be slightly obtuse. The angle at B formed by filling material would then be slightly less than a right angle if the tooth was restored to normal contour. The angle at B formed by AB and CB would be satisfactory for gold, but not for amalgam.

to be filled, the wings of the clamp are used to engage the compound, thus giving it additional support.

In case a rubber dam clamp is not used, a retainer made from stiff wire, 18 gage, is used for supporting the compound. A ring of such wire, the diameter of a silver dime and cut in half, makes two such retainers. The ends of this half circle of wire are bent in slightly, and when heated will readily engage the compound. In position, the wire retainer rests on the occlusal surface of the tooth adjoining the cavity, and its ends engage the compound on the buccal and lingual surfaces of the tooth to be filled at a point opposite the buccal and lingual margins of the proximal section of the cavity. For a mesioclusodistal cavity, two of these retainers are used. It takes only a few moments to adjust and place them in position.

With the matrix thus supported, there need be no fear of its moving with the thrust of the condenser, and better marginal adaptation and better condensation of the amalgam are made possible than in those cases wherein the matrix is not supported throughout its length. The

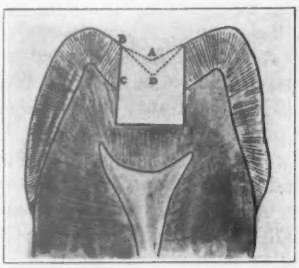


Fig. 14.—Section illustrating point that occlusal carving of amalgam restoration should not be so deep as that frequently used for gold. Should the carving extend to the point D, the angle formed by the surface of the filling DB and the wall of the cavity CB would be so acute that chipping of the margin of the filling would probably result. On carving to the point A, the angle formed by the surface of the filling AB and the wall of the cavity CB would be much less acute and hence proportionately stronger.

tight contact of the matrix to the buccal and lingual cavity margins may be loosened slightly by passing, from the cavity side, a warmed thin-bladed instrument between the matrix and cavity margin in order to permit an excess of amalgam over these margins. In view of the fact that the gingival margin is in direct line

of the thrust of the condensing instrument, it is advisable to have the matrix tightly adapted to that margin.

Although I have described the placing of a matrix for a cavity involving only one axial surface, a modification of the same method may be employed for complex restorations involving two or more axial surfaces. In fact, the more complicated the cavity, the greater the value of this method. For a mesioclusodistal restoration, for instance, two separate matrices are used, but they are threaded on the same piece of lightning floss.

*Amalgamation.*—The proper triturating time, that is to say the amalgamating period of the particular alloy used, should be known. Dr. Hollenback's findings indicate that the manufacturer's directions relative to this point are often incorrect. He also emphasizes the importance of using the correct type of mortar and pestle. A No. 8 is recommended because of the approximate fit of the pestle to the bowl of the mortar. The bowl of this No. 8 pestle has a raised center. The fit of the pestle to the bowl may be improved by grinding in with No. 2 F carborundum powder mixed with water. This may occasionally be repeated to insure the proper triturating surface at all times. The manufacturer's directions in regard to proportioning the alloy and mercury should be followed in each instance. Experience may indicate a slight change here to meet the requirements of the operator. It is well not to economize too much on the size of the mix. It is better to have some material left over than to run short. A pen grip is used on the pestle, exerting only about 2 pounds pressure and making approximately 150 revolutions a minute with the pestle. Instead of hand mulling, the mulling is done in a piece of rubber dam or in the mortar with the finger covered with a rubber finger cot.

*Filling the Cavity.*—As before stated, the condensing instruments must be so designed as to reach every section of the cavity readily. The first piece of amalgam, with very little, if any, of the mercury expressed, is placed in the proximal section of the cavity. This piece is spread and placed with the largest diamond-shaped condenser point that will readily enter that section. Each succeeding piece of amalgam added should have a considerable portion of the excess mercury expressed at the moment that it is needed. Each layer should be well condensed, first with a larger point, followed by stepping with smaller ones. From 10 to 12 pounds pressure with the larger points would not be excessive. The diamond-shaped condenser points are particularly well adapted for reaching the angles of the axial surface extensions of compound cavities. As the filling progresses, better marginal adaptation is secured by spinning the amalgam against the cavity walls and matrix. This is accomplished by the use of a small round burnisher, after each layer of amalgam is placed and condensed. The burnisher is about 0.5 mm. in diameter and is used with very light pressure. The size and shape of the condensing instruments are determined by the size and shape of the section of the cavity being filled. The final condensing of each layer should bring sufficient mercury to the surface to make it appear shiny, yet the surface should feel solid under condensing pressure.

The cavity should be overfilled with dry amalgam, the excess amalgam being dry from having had the free mercury expressed before being placed. When added to the filling and condensed, this drier amalgam absorbs sufficient mercury from the filling to make it workable; that is, sufficiently plastic.

*Removing the Matrix and Carving.*—The gross excess of the filling is carved away sufficiently to free the occlusal extension of the matrix. The compound supporting the matrix is removed after being partially softened with a heated plastic instrument. The toothpick wedge is removed and the floss engaging the matrix is cut and removed. The matrix

is then removed by pulling bucally or lingually with no tendency to traction occlusally. Usually, it would be best to remove it toward the margin best supported by tooth structure.

The marginal excess on the proximal portion of the filling is carved away, the blade of the instrument being held against the tooth structure in such a way as to minimize the danger of overcarving.

The gross carving of the occlusal area may be done before removing the rubber dam. In removing the rubber dam, the septum of the rubber between the filling and adjoining tooth is first cut. The patient is cautioned regarding biting pressure. The carving is then completed with the aid of articulating paper.

The same care is used in restoring tooth form with amalgam as in any other restoration. It is not advisable, however, to carve the sulci as deeply as might be done with gold. The angle formed by the cavity margin and the occlusal surface of the filling should, for maximum strength, approximate a right angle. The nearer one can approach that the better. Deep carving often makes this angle quite acute, thus inviting chipped margins. Deep grooves also discolor much more readily than other exposed portions of the fillings.

*Finishing and Polishing.*—The finishing and polishing of the filling are not done under twenty-four hours after insertion of the filling; several days would probably be better.

Excessive frictional heat should be avoided in finishing and polishing.

Fine and extra fine cuttle strips should be used on the gingival margins. Fine and extra fine cuttle and crocus disks are effective for buccal and lingual margins of the proximal portions. No attempt should be made to pass a finishing strip over the contact point, as the filling is condensed against a highly polished steel matrix. In fact, the frictional movement of the matrix against the contact area of the filling, while being removed, increases the smoothness of that area. Small carborundum points are used on occlusal margins where irregularities of the surface of the tooth have caused unevenness of the cavity margins, resulting in slight overlapping of the margins with the amalgam. A one-half size round bur is effective in correcting fissure and groove carvings. The finishing of the occlusal surfaces is done with flour of pumice mixed with water and applied sparingly with a cup-shaped brush wheel, followed with a high-polishing powder applied lightly with a revolving rubber polishing cup.

BIBLIOGRAPHY

1. Ward, M. L., and Scott, E. O.: Effects of Variations in Manipulation on Dimensional Changes, Crushing Strength and Flow of Amalgams. J.A.D.A., 19:1683, October 1932.

2. Hollenback, G. M.: Behavior of Amalgam and Technic for Its Use. J.A.D.A., 24: 386, March 1937.

3. Hollenback, G. M.: Economic Value of Amalgam in Operative Dentistry and Technic of Its Use. J.A.D.A., 24:1318, August 1937.

4. Hatton, E. H.: Pulp Pathology from the Standpoint of the Clinician. J.A.D.A., 17: 2262, December 1930.

2722 Foothill Boulevard.

# ROUTINE DIET AND SALIVARY ANALYSIS AT THE GUGGENHEIM DENTAL CLINIC

By Frances Krasnow, Ph.D., New York City

## DENTAL HEALTH: A RESULTANT OF AND CONTRIBUTING FACTOR IN GENERAL HEALTH

ALTHOUGH conveniently dissociated into systems, organs, tissues and cells, the complex organism *per se* remains a unit entity. Its well-being contributes, in fact is indispensable, to the absolute health of each of its parts, and the proper functioning of each part insures the optimum activity of the entire being. Dental health, then, is no less a resultant of those conditions which make for the health and life of the body as a whole than it is itself one of the factors in general health. Our program, still evolving, aims to raise the physiologic state of the patient to its optimum plane. The plan adopted provides for handling not only cases from the Guggenheim Dental Clinic, but also patients of different age ranges referred from other institutions as well as from dentists in private practice, thus introducing a concerted effort toward optimal health maintenance.

## FACTORS CONSIDERED

Careful consideration is given to the effects of:

1. The presence of formed poisons (bacteria and micro-organisms generally).

2. The presence of unformed poisons other than those originating from infection (chemical substances of varying constitution), such, for example, as arise from different industrial processes.

3. Medicodental clinical and laboratory examinations.

4. Sufficient rest to take one through the daily tasks without the feeling of fatigue.

5. Peace of mind.

6. Proper oxygen supply.

7. Balanced diet, which is viewed only as part of this comprehensive scheme and interpreted as a variable, determined both qualitatively and quantitatively by (a) age, (b) sex, (c) body build, especially weight and height, (d) occupation, (e) climate, (f) degree of freedom from fatigue (mental and physical) and (g) degree of freedom from disease.

The Murry and Leonie Guggenheim Dental Clinic Diet Booklet

Name

Address

Weight

Height

Date

Diet Record:
Specific foods and accurate amounts of each taken at every meal and between meals.

Fig. 1.—Diet booklet. (The dimensions of the booklet are 4 inches wide by 8 inches long.)

## CRITERIA OF PHYSIOLOGIC RESPONSE

Our chief criteria of physiologic re-

(Read before the Section on Histology, Physiology, Pathology, Bacteriology and Chemistry [Research] at the Seventy-Ninth Annual Session of the American Dental Association, Atlantic City, N. J., July 14, 1937.)

sponse are subjective guides, clinical manifestations (in roentgenograms), weight changes and variations in the chemical picture of saliva. Differences in salivary composition associated with different dental disorders are the result of very recent researches.[1] It may be wise, therefore, to indicate the degrees of deviation from the normal. The summary of analysis in Table 1 compares the average values obtained for normal persons with those of subjects suffering from erosion and caries.

The figures reveal that, for erosion, the average hydrogen-ion concentration, calcium, magnesium, inorganic phosphate, protein, lipid phosphorus or cholesterol lie entirely beyond those for the same constituents in saliva of normal persons. The values 6.83, 7.6, 0.75, 18.0, 446, 0.52, 11.2, respectively, are to be compared with 7.14, 6.3, 0.46, 15.2, 298, 0.13, 7.5. There are apparently two types of erosion, each showing a characteristically different salivary picture. One, with alkaline saliva, yields markedly lower concentrations: pH, calcium, magnesium and protein approach the normal; inorganic phosphate and cholesterol fall below and lipid phosphorus rises above. The other, with acid saliva, presents levels further removed from the normal.

Caries-active cases show fewer abnormal variations, non-overlapping figures appearing only for pH, magnesium, lipid phosphorus and cholesterol, with values of 6.92, 0.65, 0.20, 10.7, respectively, instead of 7.14, 0.46, 0.13, 7.5. Again, the differences are enhanced in the averages for the acid saliva subgroup, being changed to 6.71, 0.73, 0.22 and 11.9. For the alkaline series, inorganic phosphate is reduced from 14.4 to 12.6 (almost to the same level as in erosion associated with alkaline saliva); pH, calcium and protein remain normal, but magnesium, lipid phosphorus and cholesterol are high.

## ROUTINE PROCEDURE

*Conditions for a Standard Saliva Sample.*—To insure saliva samples at once duplicable and representative, conditions are set for a definite physiologic plane over a period of at least one week preceding any analysis. They include:

1. Absence of recent mishap or illness (general medical examination within the last six months).

| | Date |
|---|---|
| Chief Complaint: | |
| Present Illness: | |
| Past History: | |
| Family History: | |
| General Inspection: | |
| Description of local lesion: | |
| (1) Extraoral | |
| (2) Intraoral | |
| Urine: | |
| Blood: | |
| Remarks: | |
| Diagnosis: | |
| Operation: | |

Fig. 2.—History.

2. Thorough washing of the mouth and brushing of the teeth just before retiring the evening preceding each test day.

3. Eight hours of sleep during the night prior to each test day.

4. No brushing of the teeth or rinsing of the mouth nor having breakfast

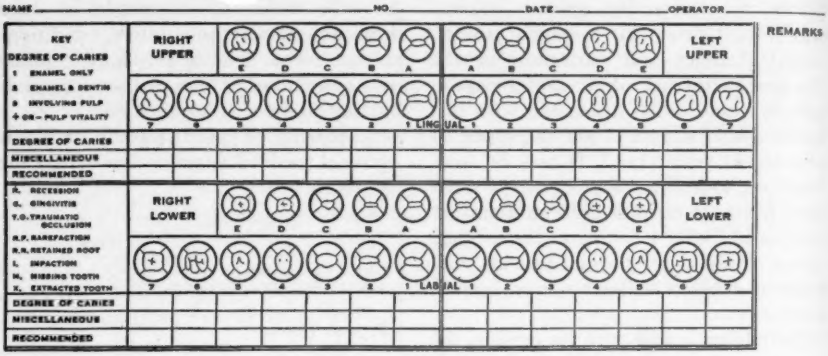


Fig. 3.—Dental chart.

THE MURRY AND LEONIE GUGGENHEIM DENTAL CLINIC SALIVA ANALYSIS

Name — Dentist
Address — Address — No.
Telephone — Telephone — Date

Age — Sex — Weight — Height — Race — Religion

General Habits:

Occupation

Hours of work — Type of work

Rest: Sleep: Hours — restless — sound

Diet: Supplementary details of diet not in booklet such as size of portion, enjoyment of food, appetite, regularity of intake.

Water

Medical Examination: Supplementary details of more personal nature previously omitted.

Saliva Collection — Start — End — Amt.

pH (cell)

Under oil

Suction

Fig. 4.—Original record card. (Obverse.) (The dimensions are 5 inches wide by 8 inches long.)

(water) or smoking on the morning of each test.

5. A one and one-half to two hour interval between rising and collections, this interval including a fifteen-minute rest period at the laboratory.

6. A detailed record of meals.

*Required Preliminary Records.*—Each patient receives the diet booklet represented in Figure 1. The pages are individually dated or otherwise marked when necessary. This is returned the morning

TABLE 1.—SUMMARY OF ANALYSES ON TOTAL UNSTIMULATED SALIVA*

| Type of Case | Number of Cases | pH | Calcium | Magnesium | Phosphorus | Protein | Liquid Phosphorus | Cholesterol |
|---|---|---|---|---|---|---|---|---|
| Normal† | 12 | 7.14±0.04 | 6.3±0.4 | 0.46±0.07 | 15.2±1.0 | 298±17 | 0.13±0.02 | 7.5±0.7 |
| Erosion‡ | 19 | 6.83±0.05 | 7.6±0.5 | 0.75±0.10 | 18.0±1.4 | 446±46 | 0.52±0.11 | 11.2±2.0 |
| Alkaline saliva | 4 | 7.19±0.07 | 5.5±0.5 | 0.42±0.04 | 12.2±1.6 | 284±33 | 0.26±0.11 | 5.3±2.1 |
| Acid saliva | 15 | 6.73±0.04 | 8.2±0.5 | 0.84±0.12 | 19.7±1.5 | 489±53 | 0.60±0.14 | 12.9±2.3 |
| Caries | 24 | 6.92±0.06 | 6.2±0.2 | 0.65±0.06 | 14.4±0.6 | 346±24 | 0.20±0.03 | 10.7±0.77 |
| Alkaline saliva | 9 | 7.21±0.04 | 6.0±0.25 | 0.63±0.08 | 12.6±0.7 | 315±33 | 0.19±0.02 | 9.2±0.7 |
| Acid saliva | 12 | 6.71±0.04 | 6.4±0.19 | 0.73±0.08 | 15.2±0.7 | 359±39 | 0.22±0.04 | 11.9±1.2 |

*Average values with standard deviations expressed in milligrams per hundred cubic centimeters.

*Excerpt from the report on Salivary Analysis in Patients Subject to "Wastings": Abrasions or Erosions, presented at the Twenty-Fourth Annual Meeting of the American Academy of Periodontology, Atlantic City, N. J., July 1937.

†"Normal" refers to subjects who, as far as medicodental clinical and laboratory examination can discern, have no ailments.

‡"Erosion" refers to subjects suffering from "wastings": erosions or abrasions.

TABLE 2.—RECORD IN CASE REPORTED

| 12/6/35 | 4/1/36 | 10/10/36 |
|---|---|---|
| I Findings: | I Findings: | I Findings: |
| A. Saliva | A. Saliva | |
| pH* 7.1 | pH 7.0 | |
| Calcium 5.3 | Calcium 5.0 | |
| Phosphorus 13.2 Tending low | Phosphorus 15.5 Increased | |
| Magnesium 0.62 High | Magnesium 0.41 Decreased | |
| Protein 300 | Protein 306 | |
| Cholesterol 10.9 High | Cholesterol 6.5 Decreased | |
| Lecithin 0.18 Tending high | Lecithin 0.14 Decreased | |
| B. Diet | B. Diet | |
| Water and milk intake low | Milk increased, water intake low | |
| Calories somewhat low | Calories increased | |
| Acid:base 61:45 | Acid:base 41:55 | |
| High bread, cake and cereal intake | Decrease in bread and cereal intake | |
| C. Dental report | C. Dental report | C. Dental report |
| Caries extremely rampant occlusally and interproximally | Apparently no noticeable change | Interproximal decalcification arrested; no new cavities; enamel texture improved |
| II Recommendations: | II Recommendations: | II Recommendations: |
| Increase milk to 3 glasses | Increase water intake | Continue with previous advice |
| Slowly increase water to 8 glasses | Use pablum instead of other cereal | |
| Slowly increase vegetables (especially raw) | Substitute fruit for cake and other dessert | |
| Slowly increase fruits (especially raw) | Use irradiated milk instead of cod liver oil | |
| Take 2 teaspoonfuls of cod liver oil | | |
| Decrease slowly bread, cake, etc. | | |
| Keep caloric intake at 1,800 | | |

*The normal ranges are: pH: 7.14±0.04; calcium: 6.3±0.4; magnesium: 0.46±0.07; phosphorus (inorganic phosphate): 15.2±1.0; protein: 298±17; lecithin (lipid phosphorus or alcohol-ether soluble phosphorus): 0.15±0.02; cholesterol: 7.5±0.7.

of the laboratory appointment and filed with the records shown in Figures 2 and 3, which have been filled out by the dentist.

*Analyses.*—After a fifteen-minute rest period at the laboratory, a specimen (0.5 to 1.0 cc.) of saliva is collected by spontaneous flow[2] for the determination of the hydrogen-ion concentration (pH), being carried out immediately.* Then a large specimen (40.0 cc.) is obtained by the aid of suction and a saliva ejector. As soon as the saliva collection is completed, the patient is questioned regarding his general habits and the medical examination, and the answers noted on the original record card shown in Figure 4. At this time, a full set of roentgenograms are taken and a final check-up of the extent of tooth involvement is made. Aliquots of saliva are measured for the determination of calcium,[3] magnesium,[4] inorganic phosphate, Ph,[3] lipid phosphorus,[4] cholesterol[6] and protein.[7] The results are entered on the original record card. (Fig. 5.)

THE MURRY AND LEONIE GUGGENHEIM DENTAL CLINIC

Name Dentist No.

Analysis: Whole Saliva Date

| Date | Det. | Sample | Reading | Calculation | Result | Final |
|---|---|---|---|---|---|---|
| | pH | | | | | |
| | Ca | | | | | |
| | Mg | | | | | |
| | P Inorganic | | | | | |
| | Liquid P | | | | | |
| | Cholesterol | | | | | |
| | Protein | | | | | |
| Miscellany | | | | | | |

Fig. 5.—Original record card. (Reverse.)

The food intake noted in the diet booklet is studied with reference to acidic factors (meat, fish, eggs, cereal, flour products), basic factors (fruits and vegetables with few exceptions), milk and milk equivalents, vitamins, water and caloric value. This probable habitual con-

*A series of standards in glass cells are prepared by adding to 0.05 cc. indicator, generally brom-thymol blue, 0.2 cc. buffer mixtures containing graded concentrations of M/15 $Na_2HPO_4$ and M/15 $KH_2PO_4$. Comparison with these determines the pH of the unknown (0.05 cc. indicator, 0.15 cc. water adjusted to pH 6.9-7.0, and 0.05 cc. saliva) in a similar cell. Usually, this procedure is checked with that outlined in *J. D. Res.*, 11: 573, 1931.

THE MURRY AND LEONIE GUGGENHEIM DENTAL CLINIC SALIVARY-DIET ANALYSIS

Re: (Patient) Date:

I Findings

A. Saliva

| | |
|---|---|
| pH | |
| Calcium | Mg. % |
| Magnesium | " " |
| Phosphorus | " " |
| Protein | " " |
| Cholesterol | " " |
| Lipid P | " " |

B. Diet characterized by

1.
2.
3.

C. Physiology

---

Copy of Recommendations sent to patient

II Recommendations Date:

A. Diet

1.
2.
3. Take

| | | | |
|---|---|---|---|
| | 2½ oz. meat or fish | | 1 large apple |
| | 1 egg | | 1 " orange |
| | 2 slices bread | | 1 " pear |
| X Portion | 1 inch cube cheese | to | 1 medium banana |
| Only | ½ cup cottage cheese | Y Portions | 1½ peaches or apricots |
| | ½ cup cereal or macaroni or noodles or corn | of | 4 large dates |
| | | | 1½ figs |
| | 4 crackers | | 1 medium potato |
| | 1 inch slice cake | | ½ cup vegetable (spinach, beet tops, carrot tops 3 times each week) |

4. Keep caloric intake at Z.

| | Values of common foods: | |
|---|---|---|
| Meat | 2½ oz. | 100 |
| Fish | 2½ oz. | 100 |
| Egg | 1 | 75 |
| Bread | 1 slice | 40 |
| Crackers | 4 | 100 |
| Cereal or macaroni or noodles or rice | ½ cup | 100 |
| Milk | 1 cup | 150 |
| Cheese | 1 inch cube or ½ cup loose | 100 |
| Potato | 1 medium | 100 |
| Vegetable | ½ cup of carrots, beets, beans, peas or like | 75 |
| | ½ cup leafy | 15 |
| Fruit | 1 large apple, orange, pear | 100 |
| | 1½ peaches, apricots | 100 |
| | 4 dates | 100 |
| | 1½ figs | 100 |
| | 15 almonds | 100 |

B. Return for analysis 5 months after diet instituted. During this time send to Dr. Krasnow record of weight and diet for last week of each month.

C. Report to Dr.—(dentist) details regarding health.

D. Have thorough medical check-up before commencing recommendations.

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Fig. 6.—Complete summary. (The original summary is recorded on a card 5 inches wide by 8 inches long.)

sumption, tabulated in Figure 7, together with the data assembled in Figure 1-5, is used to deduce the additional needs commensurate with the age, height, weight, occupation, physiologic state and climate (season) requirements.

*Summary Report.*—Finally, a complete summary is prepared as represented in Figure 6. The clinic or the dentist using our consulting laboratory service receives a copy of the entire report for filing and a carbon duplicate of the recommendations which are sent to the patient.

### REPORT OF A CASE

C. S., a girl, aged 15, of good health and coming from an excellent home, was examined at the clinic December 6, 1935, at the suggestion of her dentist and because of his concern over the generally bad condition of her teeth. Susceptibility to caries had continued despite dental care. The physician suggested an increase in dosage (two tablets three times a day) of dicalcium phosphate with viosterol, one tablet of which the patient had been taking after each meal. He also prescribed more vegetables and advised more careful mastication of all foods. In a letter to the patient's mother, he also emphasized the importance of ample fruit, vegetables and milk in the diet and the value of plenty of exercise in the open air and sunlight. The findings, recommendations and progress of the case are presented in Table 2.

THE MURRY AND LEONIE GUGGENHEIM DENTAL CLINIC DIET ANALYSIS

Re: (Patient) Date:

| Date | Totals |
|---|---|
| Acid | |
| Base | |
| Milk and equivalents | |
| Water, juices<br>Broth | |
| Calories | |

Comment:

Age Present weight Present calories
Height Required weight Required calories

Fig. 7.—Probable habitual consumption. (This record is on a card 5 inches wide by 8 inches long.)

In this particular case by increasing the milk, raw vegetables, fruit, vitamin D and caloric intake and by decreasing bread, cake and similar products, the salivary composition reverted to normal within four months and the dental picture showed definite improvement after ten months.

### CONCLUSION

There is indication that adjustment in the dietary requirements may lead to an improved dental condition. This apparently follows changes in salivary composition which are doubtless a response to general metabolic variation. It may be possible, therefore, to employ quantitative analysis of saliva as an objective criterion for effects on body state.

### BIBLIOGRAPHY

1. KRASNOW, FRANCES; HIRSCHFELD, ISADORE, and OBLATT, E. B.: Unpublished data.

2. KRASNOW, FRANCES; OBLATT, EDITH B., and KAPLAN, NAOMI: *J. D. Res.*, 15:367, September 1936.

3. KRASNOW, FRANCES; KARSHAN, MAXWELL, and KREJCI, L. E.: *J. Lab. & Clin. Med.*, 17:1148, August 1932.

4. KRASNOW, FRANCES, and OBLATT, EDITH B.: To be published.

5. KRASNOW, FRANCES; ROSEN, A. S., and POROSOWSKA, Y.: *J. Lab. & Clin. Med.*, 20: 1090, July 1935.

6. KRASNOW, FRANCES, and OBLATT, EDITH B.: *J. D. Res.*, 16:151, April 1937.

7. *Idem:* 13:239, June 1933.

# PHYSICOCHEMICAL STUDIES OF ENAMEL

## (I) DYE PENETRATION INTO ENAMEL OF ADULT HUMAN TEETH *IN SITU**

By Oscar Kanner, M.D., Chicago, Ill.

### INTRODUCTION

NUMEROUS authors have investigated the question whether enamel should be considered a living tissue. In the past, the experimental methods followed by most investigators were based upon reasoning of this kind: If enamel is a living tissue, it must have a metabolism, which would be possible only if enamel were permeable. Could it be proved that enamel is not permeable, there could be no metabolism, and enamel could not be a living tissue. If, however, enamel were found to be permeable, most authors would be inclined to conclude that metabolism, and hence vitality, is present.

There seems to be little doubt about the validity of the first phase of this reasoning; namely, that there could be no metabolism in the case of general impermeability. We say general impermeability because the statement that a substance is permeable or impermeable appears, physically speaking, devoid of meaning, unless we add certain qualifications, such as whether it is permeable or impermeable to a certain substance and under what conditions. For instance, consider a given membrane and a given solution: The membrane may be permeable to the solvent and impermeable to the solution. We then have the conditions for osmosis. Should this membrane be considered permeable or impermeable? A collodion membrane may be completely impermeable to sugars, but permeable to urea. A membrane may be permeable to kations and impermeable to anions. Such selective permeability may be altered by various factors, such as pH, electric charge, chemical composition of the fluid in contact with the membrane, ionization and swelling. We shall briefly review methods (listed in the accompanying table) available for studying permeability, discuss current theories of permeability and consider their relationship to the enamel problem.

Among the direct methods, only the first one, penetration of dyes, has been used on enamel. This method is open to objection: the dyes are foreign to the organism and do not permit a conclusion as to substances physiologically present. In general, the question of tissue staining is still controversial. For instance, it has been claimed that in so-called vital staining, only lifeless inclusion particles are stainable. Most cytologists seem to be of the opinion that no dye has been found capable of staining living matter. The penetration of certain dyes into living cells has been considered a phenomenon of ultraphagocytosis. Hence, positive staining of enamel would not permit the conclusion that we are dealing with a living tissue. We wish to call attention here to a possible source of error to be considered when using this method; namely, that a dye may undergo such changes within a

(Read before the Chicago Section of the International Association for Dental Research, May 21, 1937.)

*From the Foundation for Dental Research of the Chicago College of Dental Surgery.

tissue that it becomes indetectable. Methylene blue, for instance, becomes colorless if exposed to fluids having a partial pressure of hydrogen (rH) beyond a certain limit. This dye has been used for vital staining of nerves, but the stain becomes visible only after the death of the tissue stained with it.

The methods of Group 2 (visible cell changes) can hardly be applied to enamel.

The third group has not yet been tried on enamel, probably because of technical difficulties. Worth while results from this otherwise ideal method can be expected. The difficulties are due to the fact that only small quantities of substances are available for analysis. Modern methods, however, should overcome this obstacle.

PRINCIPAL METHODS FOR STUDYING PERMEABILITY

| Direct Methods | Indirect Methods |
|---|---|
| 1. Penetration of dyes* | 1. Plasmolytic methods |
| 2. Visible cell changes due to penetration of a substance | 2. Turgor methods |
| 3. Direct quantitative chemical determinations† | 3. Indirect chemical methods* |
| | 4. Physicochemical methods* |
| | 5. Special physiologic methods |

*This has been applied to enamel.
†This could be applied to enamel.

Policard, for instance, has recently developed a procedure of micro-analysis of histologic sections by means of an emission spectrum produced by an electric spark.

Among the indirect methods, chemical and physicochemical methods have been applied to enamel which used the enamel as the membrane of an osmometer or an ultrafilter. The evidence presented by various authors is contradictory. It seems that those who obtained considerable permeability to salts were not sufficiently aware of the possible presence of cracks in their enamel preparations. Those who took enough precaution to exclude this source of error and yet obtained good permeation of the experimental fluids worked on extracted teeth which had previously been soaked in water for periods up to several months. Such experiments do not really permit conclusions as to the permeability of enamel.

Klein[1] found that enamel behaved like a dried collodion membrane. By using enamel as a separating membrane between solutions of different concentration of one and the same electrolyte, he obtained electromotoric forces comparable in value to those observed by Michaelis with dried collodion membranes. Klein concluded that there is a certain degree of permeability in enamel. But his conclusion is based upon the *a priori* assumption that enamel is built like a more or less porous membrane. Similar potential differences may be obtained with a glass electrode, and yet no one would reasonably conclude that glass is permeable to electrolytes. Also, Klein made use of teeth that had been soaked in water.

A number of other physicochemical methods are still waiting to be applied to enamel. Conductivity methods, for instance, appear promising.

Following Gellhorn,[2] the theories of permeability may be grouped as follows: (1) lipoid theory, (2) colloid theories, (3) adsorption theory and (4) ultrafiltration theory. It seems that most authors concerned with the enamel problem, in particular those who wanted to reason

from permeability to metabolism, considered the ultrafiltration theory only, and the rôle of pore size exclusively. According to this theory, parts of living tissue behave like porous membranes, and permeation through the pores depends on their size, the electric charge of the membrane and other variables.

The lipoid theory has become quite popular since Overton. Lately, Hartman has given consideration to this theory in the case of dentin. His desensitizing fluid was designed to be lipoid-soluble. It can be safely said that the penetration of lipoid-soluble substances into living tissue does not necessitate pores.

There are a number of colloid theories, but at present we do not see a direct relation to the enamel problem except for the fact that some of them admit permeation in the absence of pores.

The adsorption theory does not call for pores. According to Zipf (quoted from Gellhorn), chemical combinations and exchange of ions play their part in permeation.

We agree with all previous investigators as to the great practical importance of the problem of enamel permeability, and we plan to carry out experimental work along this line. This we have already started and we are in a position to report the results of a series of experiments.

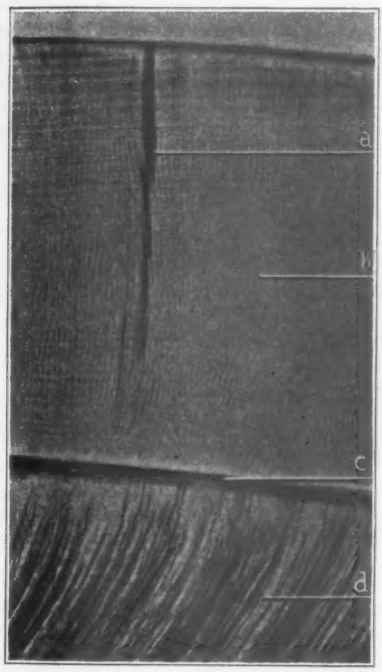


Fig. 1.—Ground section of enamel and dentin (from Orban). The dark zone, c, referred to as the dentino-enamel junction in the text, corresponds to the membrane separating enamel and dentin.

### EXPERIMENTAL PROCEDURE

Powdered polychrome methylene blue is mixed with water to make a paste. A thin layer of this paste is placed upon the enamel surface of intact teeth prior to extraction, and protected from saliva by means of a rubber dam. From five to thirty minutes after the application of the dye, the teeth are extracted and the enamel surface is cleaned at once with an abundance of running water which rapidly dissolves all of the dye present upon the surface of the tooth. Next, cross sections or longitudinal sections are made through the teeth by means of a cutting disk.

### EXPERIMENTAL RESULTS

The results are uniform in all teeth treated in this way. In all instances, without a single exception, all of the enamel the surface of which was exposed to the dye is diffusely stained. The stained area comprises the whole thickness of the enamel and ends abruptly at the dentino-enamel junction.

### COMMENT

One might raise the question whether the dye had actually penetrated the enamel or whether it was carried from the surface into the deeper layers by the disk when the tooth was cut. There are three converging arguments that support

the first possibility and eliminate the second:

1. The surfaces of the teeth were thoroughly cleaned by water, which would remove any excess dye.

2. Grinding the cut surface on a stone did not change its appearance as to the distribution of the stained areas.

3. The dentin remained unstained in all instances. If the disk had carried the dye into deeper layers, there would be no reason that this action should end exactly at the dentino-enamel junction, especially if we consider that the dentin stains immediately and very well when exposed to the same dye. This we have repeatedly confirmed by applying a drop of a dye solution to the dentin under the stained enamel. Hence, if the disk could spread the dye, the limits of stained and unstained areas would not correspond exactly to the dentino-enamel junction.

Besides polychrome methylene blue, two other dyes have been used with equal success: ordinary methylene blue and gentian violet.

The teeth used in the experiments were from persons ranging from 15 to 70 years.

Now the question arises as to why the dye penetration stops at the dentino-enamel junction. In view of the fact that dentin as well as enamel is susceptible to being stained by the polychrome methylene blue, it appears that the phenomenon can be explained only by the hypothesis that a barrier, impermeable to the dye under the conditions of the experiment, is present at every dentino-enamel junction. Efforts have been made to find out whether there is any structural evidence of such a barrier. It was noticed that a well-defined narrow zone, structurally different from enamel as well as from dentin, is visible in almost any section, whether it is ground or decalcified. Most any existing textbook illustration will show this structure. Like a membrane, it covers the entire surface of the dentin and separates it from the enamel. As far as we know, no reference has ever before been made to this structure. The legends of most textbook illustrations merely designate it as the dentino-enamel junction. Further proof of the real existence of this membrane was obtained from ash pictures of decalcified sections, which reveal that the membrane in question contains organic material and that this organic matrix is richer in minerals than the surrounding structures.

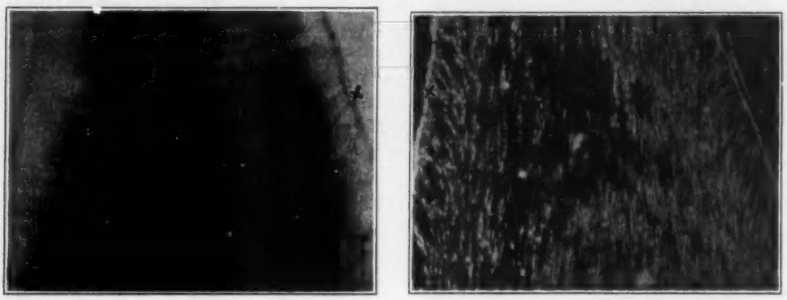

**Fig. 2.—Left, section through decalcified unerupted tooth stained with hematoxylin and eosin. The membrane (X) is noticeable at the surface. Right, ash picture of an incinerated section from decalcified tooth (at left) seen with reflected light. The mineral ash of the membrane is conspicuous.**

Figure 1 is a photomicrograph of a ground section of enamel and dentin (from Orban[3]). At the dentino-enamel junction, a dark zone is visible, separating the two tissues. The legend refers to it as c, dentino-enamel junction.

Figure 2 is a section of an unerupted tooth. The enamel has been dissolved by

decalcification in 5 per cent nitric acid. Figure 2, left, is a photomicrograph of a hematoxylin-eosin stained section. Figure 2, right, is the ash picture (obtained with reflected light) of a neighboring section. The described membrane is conspicuous in both sections.

Figure 3 is a higher magnification of the membrane seen in the ash picture.

Figure 4 shows the dentinal tubules impregnated with silver. It can be seen that the tubules do not reach the surface. This, in my opinion, is due to the membrane, X, in question.

From this investigation, three things appear probable:

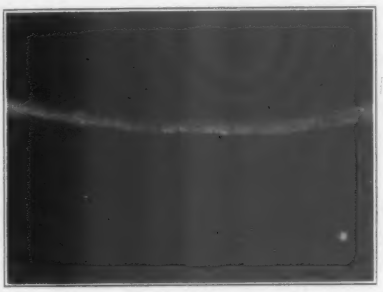

Fig. 3.—Higher magnification (×1,000) of the membrane seen in Figure 2, right.

1. Other substances than dyes are capable of permeating enamel, in particular, constituents of the saliva.

2. Permeation of enamel is possible because of the presence of a diffuse organic matrix.

3. The observed permeability ends at the dentino-enamel junction because of the presence of the described membrane.

Further studies, using direct chemical methods in particular, are planned, and it is hoped that they will throw additional light on certain problems related to the anatomy, physiology and pathology of enamel.

## CONCLUSIONS

1. Intact enamel of adult teeth *in situ* is completely permeable to certain dyes.

2. The permeation extends to the dentino-enamel junction and no farther.

3. A definite membrane is present at the dentino-enamel junction of all teeth.

4. It appears probable that this membrane constitutes a barrier to the permeation of the dyes into the dentin.

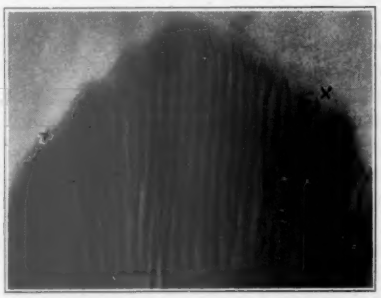


Fig. 4.—Section through decalcified deciduous incisor. The dentinal tubules are impregnated with silver. They do not enter the membrane (X) on the surface of the dentin.

5. It is probable that constituents of the saliva normally penetrate the enamel.

## BIBLIOGRAPHY

1. Klein, Henry: *J. D. Res.*, 9:667, 1929.

2. Gellhorn, E., and Regnier, J.: La perméabilité, etc. Paris: Masson & Co., 1936.

3. Orban, Balint: Dental Histology and Embryology. Philadelphia: P. Blakiston's Son & Co., 1929, p. 30.

# BALANCED OCCLUSION IN RELATION TO LOST VERTICAL DIMENSION

By C. J. Stansbery, D.D.S., Seattle, Wash.

BALANCED occlusion involves a definite arrangement of tooth contacts in harmony with the mandibular movements. An acceptable vertical dimension is but one of the many necessary relations of the mandible to the maxillae. Any one can exist without the others. The problem is to arrive at that particular vertical height at which balanced occlusion will function at its best, in mastication, in preservation of esthetic values, in comfort and in the establishment of muscular equilibrium. In the partial loss of teeth, the vertical dimension is dependent on the occlusion of the teeth remaining. If these teeth are erect in their sockets and not unreasonably worn, one may be quite sure that the closure as compared to the original vertical height is slight, and it is very doubtful whether this small error should be corrected.

To answer intelligently the question whether to increase the vertical dimension, we should consider carefully the accompanying conditions. The prime cause of loss in this dimension is the shortening of the teeth, from wear; extensive loss of masticating surface, the result of extraction; loss of occlusal antagonists of the remaining teeth; the presence of prostheses that are too low, or other conditions. These are the causes: now to the effects. The most apparent is the loss in vertical dimension and change in facial contours. But this is only one of the effects. Among the many others is the approximation of the origin and insertion of the masticating muscles. This muscle deflection is accompanied by a change of direction of the muscle force, which, in turn, will eventually bring about a change in mandibular form, noticeably the increased obtuseness of the ramic angle. Still another effect is that of the change in form of the condyles and in their seats in the glenoid fossae. To these effects might be added the impaired function of the pharyngeal musculature.

In the gross consideration of the cause and the effects, the cause comes first and the deviation from the previous condition leads to the ensuing effects. The greater the deviation, the greater the stimulus. It would greatly simplify our problem if the lag or unabsorbed stimulus still exerting itself to further change could be nullified by a return to that degree of change harmonious with the present status of the effects. Unfortunately, we cannot be assured that all the effects shall be of the same degree of change. Some structures may answer the stimulus less promptly than others; bone, for instance, probably more slowly than soft tissue. Some changes will have taken place, such as in ridge relations and resorption and condylar form; changes which we cannot hope to be retroactive even with a return to original dimensions. All in all, it seems to me, the best solution of the question of vertical dimension is not an arbitrary return to erase the changes of years, but a diagnosis with moderation, taking into consideration

(Read before the Section on Partial Denture Prosthesis at the Seventy-Ninth Annual Session of the American Dental Association, Atlantic City, N. J., July 14, 1937.)

form and efficiency. If in so doing, we decide that marked improvement is probable if the vertical dimension is increased, by all means let us increase it.

To me, balanced occlusion involves precision in tooth arrangement, and its maintenance, even if it is possible to once obtain it, cannot be lasting if a portion of the replaced teeth be supported on the resilient base offered by the ridge tissue. Balanced occlusion is not in itself the ultimate objective, but a means to an end, masticating efficiency with trauma so slight that it will be stimulating rather than destructive. With cuspless occlusal surfaces, balance is an impossibility except in the hypothetical case in which condyle paths follow and occlusal surfaces overlay similar or concentric spherical surfaces in all of the mandibular excursions. The reason for this is simple. A spherical surface is the only one upon which another spherical surface can be overlaid and then moved in three or more directions and maintain contact at all points. A surface in contact with a cylinder will permit of two directions, whereas an ovoid solid permits of only one.

In the analysis of balance or of uniformity of facet contacts, the problem will be simplified by considering the condyles as two fixed facets. We know that three points in contact determine the relative position of two solids, and as the two condyles, with their positions and directions, furnish two of these points, one single cusp facet, with its position and direction of movement, will furnish the third point and determine the relationship of the mandible to the maxillae. All other facets must be in harmony as to the position and direction as determined by these three. Another feature to be called to your attention is that we are confronted with three distinct problems, one for each of the major directions of movement, two lateral and a protrusive. This distinct division simplifies rather than complicates the use of cusp teeth. In one lateral movement, we are to form facets on the teeth which will be in uniform contact with the balancing and pivoting condylar facets. This is one separate set of facets, and not one of them is in contact while the other facets formed by the opposite lateral movement are in function. Both sets of lateral facets are out of function while the protrusive facets make their individual contacts. This simplifies the problem for the reason that we are not called on to make facets which have double or triple functions to perform, but only the one set of facets for the one movement with which we are working.

While balance of the flat or cuspless tooth has been shown to be impossible, its use in masticating is possible only by direct lateral thrust, the force of which must be absorbed by either ridge or abutment. The flat surface does not allow any part of the vertical power of closing to be diverted into lateral crushing effect. The resistance to lateral slide due to porcelain friction is at its maximum and puts that much greater load on both ridge and abutment. Over 30 per cent of the force expended vertically on two porcelain surfaces is necessary to make them slide on each other with no other resistance than their own friction. This means that the lateral force necessary to cut with the advancing edges of horizontal teeth is not the only force the ridge must withstand: added to it is 30 per cent of the power necessary to keep the teeth in contact.

The lateral excursions of all partial prostheses can be divided into five groups, the classification being based on vertical height and desired cusp slope. The first three of these groups leave the vertical height undisturbed. The first group follows the natural facets. The second reduces the cuspal slope, which might be indicated if cuspids were in such scissor-like occlusion as to separate other occlusal surfaces throughout an excursion. This is remedied by reducing the slope of the interfering cuspids. The third group in-

cludes those cases in which an increased cuspal slope is essential. The fourth calls for increasing the vertical height and moving this height into lateral contact with natural facets. This would include those not acceptable in class two owing to excessive grinding. In the fifth and last group, both new vertical height and facets are required. There is no fundamental difference between the requirements of this group and those of full dentures.

Proper cuspal slope has often been mentioned. Why this insistence on cusps? Because it is the only means whereby the vertical force of closure can be broken up into two diagonal forces, one impinging on cusp slope and the other exerted against a bolus of food. The horizontal elements of these two diagonal forces neutralize each other so that the ridges, and abutments are subjected to the vertical force only. The advocates of the flat and near-flat teeth entirely ignore this most important quality of the cusped tooth. Instead, it is rejected because the elevation of the cusps furnishes an obstruction to free lateral movement. This criticism would be valid if one were to hold the jaw firmly in centric position and then attempt to move the mandible horizontally; but such movements have no place in masticatory requirements. I am thoroughly in accord with the contention that a cusp in the wrong place is worse than no cusp at all, but this is not saying that no cusp is better than a cusp in the right place. Another erroneous and misleading argument advanced in the attempt to bolster up the false claims regarding cuspless teeth is the illustration of cusps midway during their slide from working to centric relation. In this act, vertical force is described as impinging on the inclined plane of the cusp, causing a lateral shift that is traumatic and detrimental to the supporting ridges and abutments. The glaring unsoundness of this illustration lies in the fact that, in the masticating groove, there is no bolus of food to absorb and divert this lateral thrust to a useful purpose. If there is no food to be crushed, only the force necessary to raise the weight of the mandible is exerted, leaving little or none to be diverted to lateral thrust. Also, the tactile sense of the teeth would act on the muscles to direct the diagonal direction of closure. These shortcomings of cuspless teeth have been brought to the attention to emphasize their absence in the analysis of the action of the cusp teeth.

To illustrate the physical action taking place between cusp teeth, let us take the example of splitting wood. The axe or wedge is driven into the wood in the direction of the lengthwise grain, and force is exerted in this direction. But what happens? The wedge, having inclined sides, exerts lateral force against the adjacent wood and this lateral force shows its power by pressure in opposite directions to accomplish the required results. These two opposite forces completely neutralize each other and do not exert any lateral force on the piece of wood as a whole. There is probably not a man in practice who has not had a case of split bicuspid or molar, from the wedgelike action of an opposing cusp. Can any one recall such an occurrence with badly abraded and flattened occlusal surfaces? No. This power to split teeth is too valuable a masticating asset to discard.

My mere statement that nature did not intend the teeth to withstand a lateral force is not sufficient without supporting evidence. Artificial teeth are subjected to the same lines of force as are the natural teeth in function. The long axis of the tooth presents a physical and biologic answer as to the proper direction of force it should withstand. Lateral forces on tooth roots should be reserved for the intentional use of the orthodontist. The roots are embedded in and supported by the alveolar process, but what, in turn, supports this process? The usual discussion of this subject, goes only as far as the

occlusal surface. Here, we have gone beyond occlusion to tooth roots, through the supporting process, finally observing the resistance form of the thin plates of bone upon which the whole structure rests. The process may cushion and soften the impacts of mastication, but it does not in the slightest change the direction of the impact. An intensive physical and biologic study of the bony support is very enlightening and leads us to but one conclusion. A thin flat bone such as an antral wall will withstand one and only one line of force and that parallel to itself. This should answer the question as to the correct line of the stress which an occlusal surface transmits through its chain of supporting structures.

There can be no possible dissension from the fact that the average line of force lies in the sagittal plane because the muscular structures are similarly constructed on the two sides of this plane. Viewed laterally, the force of closure while condyles are seated is upward and forward. The force from protrusion to centric is upward and backward. A vertical line results from these two and of course is in the sagittal plane. This vertical force has been well demonstrated by Drs. Wilson, Gysi and Williams in their studies of the mandibular leverages.

No prosthesis can be constructed to function in centric, protrusive and lateral relations unless we have a method of determining these relative positions for each individual patient. This determination is the function of check-bites. Check-bites are not empty gestures and formalities, but as essential as the impression and preparation of the abutments. The determination of centric relation by the remaining occlusion or by the guide of the gothic arch tracing in cases of increased vertical dimension is well known and should need no explanation here. It is the most important of all relations because it is the beginning and end of all excursions. The masticating cycles all start from and end at centric occlusion, but their route and destination should be just as definite as their starting point. The dentist should know and record the direction and distance to these eccentric positions, which can be determined from the patient and the patient only. This excludes the use of all arbitrary and average movement articulators. In a lateral relation, for example, the mandible must actually be moved by the patient to the exact position both laterally and vertically that it will occupy when the teeth are to be arranged in working and balanced relation. How and where is this position to be established in relation to the centric position? The technic varies slightly for each of the five groups mentioned, but is the same in principle.

In Group 1, in which the natural facets of remaining teeth are followed, the procedure is simple. Check-bites of modeling compound may be taken in centric relation, of incisors edge-to-edge for protrusion and of lateral incisors by observing the contacts of the facets in these positions.

Group 2 calls for reducing the cusp slopes of remaining teeth if they guide to a too abrupt opening. When this has been done the case is in group one.

Group 3, in which the centric relationship is acceptable, but the cusp slope should be increased, demands an aid to maintain the increase in the eccentric vertical dimensions. As previously mentioned, one point in conjunction with the two condyles establishes the position of all other points on the mandible. This relation may be recorded in various ways. One may construct a cuspal slope on any remaining single abutment, preferably anterior. Modeling compound may be molded against the palate just distally to the incisors and its exposed surface flattened and inclined to direct the eccentric movements. On this surface, the lower incisors slide and thereby "generate" slopes of the remaining teeth. Lock bites may be constructed to hold remaining teeth in the desired lateral positions. Any

of these methods will maintain the relation while the check-bites are being made.

Group 4 presents no difficulties. The increased vertical dimension in centric relation is easily registered by a modeling compound bite sufficiently thick to lessen the cuspal slope from this recorded position to the eccentric contact of the facets to be used. The recording of the eccentric relations is as in Group 1.

Before taking up Group 5, I wish to show the relation between porcelain friction and cusp slope. In a discussion of occlusal forms, last year, Dr. Gysi said that cusp slope and the attendant porcelain friction was the next field that needed further research for the thorough understanding of denture efficiency. During the week of the National Society of Denture Prosthetists meeting last year at which I showed my experiment with porcelain friction, Dr. Gysi read a paper at Oslo, Norway, on the same subject. It was a gratification to me that although we had no knowledge of each other's experiments, we arrived at a conclusion within one-half of one degree. This conclusion is that when two porcelain surfaces are under a line of force 17½ degrees from perpendicular, they will slide on each other. In any inclination less than this, the sliding force is entirely absorbed by the resistance of porcelain friction. From these findings, the coefficient of porcelain friction is deduced as being 0.315. Dr. Gysi gave me his formula as: sliding force = norm × coefficient, which is the formula for the critical angle or the least angle at which porcelain slides. The formula I gave last year was: crushing force = sine angle — (coefficient × cos angle), which is a general formula for the residual force after the porcelain friction has been absorbed.

With a check-bite technic by which it is possible to established any desired cusp slope, we should know how the different slopes act against each other before we can intelligently make our selection. If we select a tooth having an intercusp angle of 120 degrees, a vertical force of 10 pounds will only deliver 2.3 pounds in sliding force against the buccal surface of the lingual cusp of an upper molar. This can be increased to 4.8 pounds if the mandible is directed 15 degrees toward the median plane. I do not believe that a greater divergence from vertical is desirable, as we seldom see tooth roots of a greater spread than 30 degrees, 15 degrees on each side of the average axis of the tooth.

The last group, Group 5, in which both the vertical height in centric relation and the setting of cuspal slopes must be determined, present the same problem as in full dentures. The centric relation having been located at the acceptable vertical opening, we may establish any slope by increasing the cusp height of the proposed cusp and having the patient move the jaw laterally the horizontal distance of the cusp apex of the sulcus. These two dimensions can be measured from the teeth to be used. In taking the check-bites, any of the check-bite appliances equipped with a central bearing screw will provide a way to increase the vertical height equal to the height of the cusp desired. The length of the arcs from the apex of the gothic arch tracing at the time the check-bite is taken is a control for the amount of lateral movement. The ratio to each other of these two dimensions establishes the degrees of cuspal slope.

A point which cannot be overstressed is that the articulator is but the means of registering our findings from the patient. In itself, it should be as blank as an unexposed film, yet capable of development to produce a picture of the movements of the patient. A dentist determines the class of service which he can deliver to his patients when he selects his articulator because the limitations of the instrument become his limitations. Limited to a chisel and file, one might with infinite patience cut out a hole approximately round; but with a brace and bit, the di-

mensions of the hole would be accurate.

In any restoration in which a portion of the prosthesis rests on movable tissue, grinding in the mouth is contraindicated because precision of position is impossible. Spot grinding cannot be more accurate than the thickness of the articulating paper permits; an error too great to be tolerated. A check-bite procedure which registers positions in the mouth is the crux of this technic, the articulator being but the recording instrument on which this information is accurately filed in a manner easy of access and reference. If the check-bites are carefully made, and the instrument is capable of precision adjustment and the restoration ground to conform to the recorded movements, there is no reason for any mouth or spot grinding.

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# MOISTURE, INORGANIC AND ORGANIC CONTENTS OF ENAMEL AND DENTIN FROM CARIOUS TEETH*

By MARIAN L. LEFEVRE, M.S., and RICHARD S. MANLY, M.A., Rochester, N. Y.

PREVIOUS work from this laboratory by Crowell, Hodge and Line[1] and LeFevre and Hodge[2] has established normal values and the variations for certain chemical components of whole teeth. After the development of a method for the rapid quantitative separation of enamel and dentin (Manly and Hodge[3]), it was possible to investigate the chemical composition of all of the enamel and all of the dentin separately from the same teeth. As a first step, the ash and moisture contents of the separated enamel and dentin from sixty-five sound and carious teeth were determined. The purpose was to find any correlation which might exist between the values obtained and the extent of caries.

The extensive literature on the chemical composition of whole teeth is not pertinent to the question of the composition of the separate hard tissues, since there is no information as to the relative amounts of the enamel and dentin present. Recent literature on the separated hard tissues is not concerned with the moisture content. Bowes and Murray,[4] in 1935, reported values of 95.38 per cent ash for dry enamel* and 71.09 per cent ash for dry dentin.* Their method of separation was to grind specimens from the enamel and from the dentin toward the dentino-enamel junction. Their specimens were not composed of the entire enamel or dentin of the tooth. Carious bicuspids were found by these authors,[5] in 1936, to have 95.39 per cent ash for the enamel* and 73.46 per cent ash for the dentin (each based on dry weight). Since no previous investigation has published data on all the enamel and all the dentin from the same tooth, previous values for ash and organic and water contents of enamel and dentin are not directly comparable.

(Read before the Section on Histology, Physiology, Pathology, Bacteriology and Chemistry [Research] at the Seventy-Ninth Annual Session of the American Dental Association, Atlantic City, N. J., July 14, 1937.)

*This work was supported in part by a grant from the Rockefeller Foundation and in part by a grant from the Carnegie Foundation.

*From the Department of Biochemistry and Pharmacology, the University of Rochester School of Medicine and Dentistry.

*These values were reported on an ash nearly carbon-dioxide free.

PROCEDURE

In order to permit comparisons on different teeth from the same mouth, most of the teeth were obtained from three full-mouth extractions. The teeth were obtained at the Strong Memorial Hospital, placed in tap water immediately after extraction and cleaned, and carious tissue removed. Notes were made on their condition. The teeth were then pulverized and the enamel was separated from the dentin according to a flotation method noted previously.[3] For these analyses, however, an adaptation was made in the procedure to permit determination of the water content. The enamel and dentin, after separation, were washed onto watch glasses with chloroform and set in a desiccator which contained both water and paraffin. Within twelve hours, at room temperature, the chloroform had distilled over into the paraffin and the tooth powder had come to equilibrium with a 100 per cent humidity atmosphere.

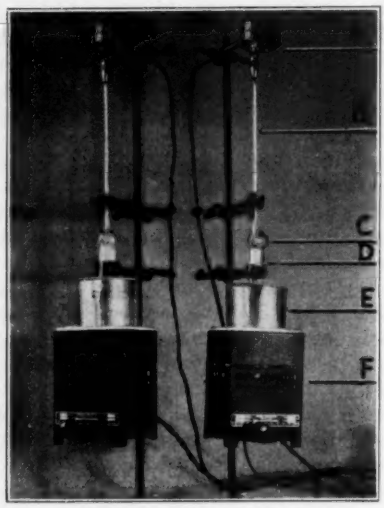


Fig. 1.—Apparatus for determination of inorganic percentage of powdered enamel or dentin. Motor A drives stirrer B through reflux bulb C in centrifuge tube D, which is surrounded by air bath E set on heater F.

(Some difficulty has been experienced in warm weather when the rapid loss of chloroform chilled the surface of the watch glass so that drops of water collected on the powder. This necessitated transfer of the watch glass to a desiccator with 95 per cent humidity until the excess water was distilled off.) This equilibration was assumed to restore any water lost during powdering. The powder was then transferred to a vial and weighed, and the weight taken as the moist weight. To obtain the dry weight, the vial was reweighed after *in vacuo* drying for six hours at 110° C.

For determination of the ash percentage, the sample was transferred to a 50 cc. centrifuge tube. Extraction of the tooth powder was carried out by a modified Gabriel ash method, using 5 cc. of a

TABLE 1.—REPRODUCIBILITY OF THE ASH PROCEDURE ON DRY DENTIN

| Particle Size | Inorganic Contents | Average | Deviation from Average |
|---|---|---|---|
| | Per Cent | Per Cent | Per Cent |
| 40-60 mesh | 80.40 | 80.24 | 0.18 |
| | 80.06 | | |
| 60-80 mesh | 80.79 | 79.80 | 0.28 |
| | 79.52 | | |
| 80-100 mesh | 81.11 | 81.33 | 0.21 |
| | 81.54 | | |
| 100-150 mesh | 80.41 | 80.52 | 0.12 |
| | 80.66 | | |
| 150 mesh | 82.07 | 81.87 | 0.21 |
| | 81.66 | | |
| | Average | 80.75 | 0.20 |

TABLE 2.—EXTENT OF CARIES IN EACH PATIENT

| Class of Caries | Number of teeth | | |
|---|---|---|---|
| | E. R. | C. L. | J. L. |
| 0 (no caries) | 3 | 1 | 3 |
| 1 (slight) | 9 | 7 | 3 |
| 2 (moderate) | 5 | 7 | 5 |
| 3 (severe) | 3 | 3 | 12 |
| Total | 20 | 18 | 23 |

3 per cent solution of potassium hydroxide in ethylene glycol for every 100 mg. of tooth substance, and vigorous mechanical stirring during the two hour heating period. Figure I shows the apparatus employed.

An air bath surrounding the centrifuge tube furnished the heat; a small motor provided the agitation to prevent bumping, and a portion of a drying tube was set in the centrifuge tube to cause refluxing of the boiling glycol. After the glycol had cooled, the tube was centrifuged for thirty minutes at 2200 r.p.m., the glycol decanted and 25 cc. of water added to the powder. This was brought just to a boil on the apparatus, centrifuged and decanted and the powder was transferred to a tarred, porous-bottom crucible and washed twice with hot water. The powder was dried *in vacuo* at 110° C. for six hours and the crucible weighed. The difference between the two weights of crucible was taken as the ashed weight of the powder.

The reproducibility of the method is indicated in Table 1, which reports the results of five duplicate analyses on size graded dry dentin samples. The mean deviation of the analyses amounts to 0.2 per cent.

## RESULTS

The three patients, E. R., C. L., and J. L., provided twenty, eighteen and twenty-three teeth, respectively, for analysis. Classification of all the teeth from each patient, according to the severity of caries, is shown in Table 2. Because third molars are often not comparable to the rest of the teeth in a mature mouth, the values found for the third molars have not been included.

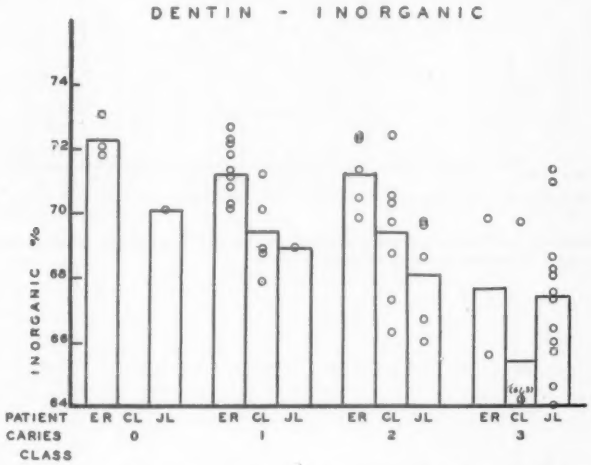


Fig. 2.—Inorganic percentages (moist weight) of dentin from single teeth plotted as ordinates against caries class. Values for each patient are shown separately. In Figures 2 to 6, the height of the column represents the average value for a given patient; the circle represents individual teeth. There is a low value of 61.3 for Class 3 (patient C. L.). A tendency to decrease with increasing caries severity is evident.

A plurality of the teeth from patient E. R. fall in Class 1; the teeth of C. L. are mostly divided between Classes 1 and 2, and the majority of the teeth of J. L. are in the severe caries class (Class 3).

Complete data for the analyses of the enamel and dentin separately are given

in Table 3. The data are grouped in parts A, B and C for the three patients, E. R., C. L. and J. L., respectively. The following data are recorded for each tooth: (a) tooth position, (b) caries class, (c) moist weight of whole tooth, (d) total loss during separation, (e) percentage of enamel and (f) moisture and inorganic and organic percentages of enamel and dentin separately.

The moist weights varied from 0.3637 to 2.8734 gm.; the total loss on separation from 0.37 to 18.8 per cent, average 6.1 per cent. The enamel percentages varied from 0.1 to 24.0 per cent, the low values resulting from the caries process. The average, maximum and minimum values for moisture and inorganic and organic percentages of enamel and dentin are given in Table 4.

*Inorganic Percentage.*—In Figure 2 are given the values for the inorganic percentages (basis of moist weight) of dentin on all three patients. The inorganic percentage is shown on the ordinate and the values grouped on the abscissa

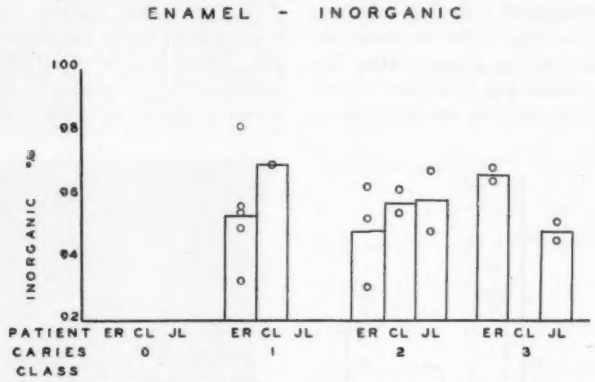


Fig. 3.—Inorganic percentages (moist weight) of enamel from single teeth plotted as ordinates against caries class. No correlation is evident.

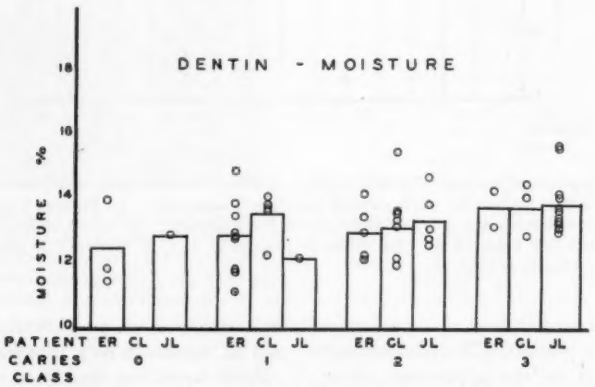


Fig. 4.—Moisture percentages of dentin from single teeth plotted as ordinates against caries class. There is a gradual rise with increasing caries, but no essential difference between patients.

according to class of caries from 0 to 3, and also according to patient within each class. From left to right, there is increasing severity of caries between the groups; from left to right within the group, increasing severity of caries between patients. For example, the height of the first column represents the average of the individual determinations (shown by circles) of the three teeth from patient E. R. which exhibited no visual evidence of carious lesions.

A comparison of the inorganic percentages of the dentin for the teeth of different patients in the same caries class shows a stepwise fall in the averages from the least carious mouth (E. R.), through the moderately carious mouth (C. L.) to the most carious mouth (J. L.), in Classes 1 and 2. In the remaining two caries classes, Class 0 and 3, the patient with the least advance of caries (E. R.) shows a higher inorganic percentage than the patient with the most carious condition. Rigorous statistical treatment cannot be applied to the data as a whole because of

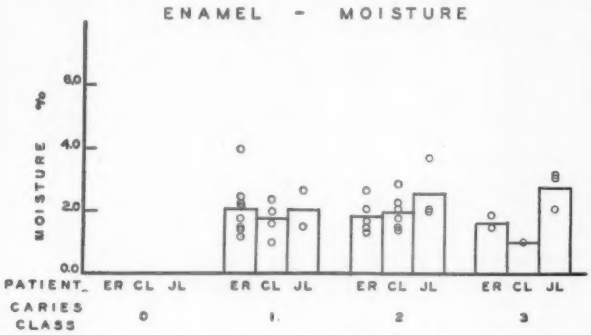


Fig. 5.—Moisture percentages of enamel from single teeth plotted as ordinates against caries class. No correlation is evident.

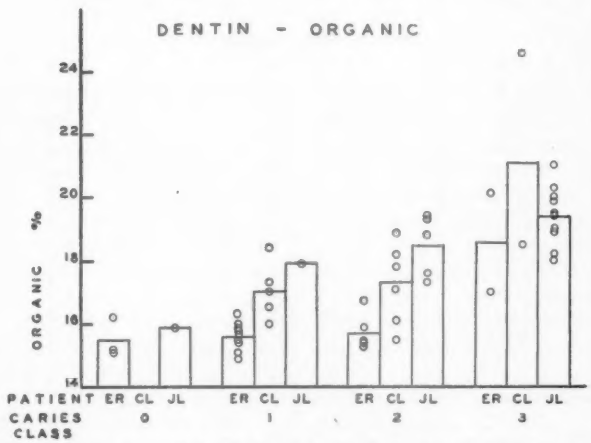


Fig. 6.—Organic percentages of dentin from single teeth plotted as ordinates against caries class. There is a tendency to increase with increasing caries severity.

TABLE 3.—COMPLETE DATA ON ANALYSES OF SEPARATED ENAMEL AND DENTIN*

| Tooth Position | Caries Class | Moist Weight of Whole Tooth | Tooth Loss During Separation | Enamel | Enamel Moist Weight | | | Dentin Moist Weight | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Per Cent | Moisture Per Cent | Inorganic Per Cent | Organic Per Cent | Moisture Per Cent | Inorganic Per Cent | Organic Per Cent |
| | | | | A: E. R., aged 41 | | | | | | |
| −1 | 0 | 0.4626 | 14.9 | — | — | — | — | 11.7 | 72.1 | 16.2 |
| −2 | 1 | 0.6393 | 3.8 | 5.4 | 1.3 | — | — | 11.8 | 73.0 | 15.1 |
| −3 | 1 | 1.0410 | 5.2 | 5.1 | 2.3 | — | — | 12.9 | 71.8 | 15.8 |
| −4 | 1 | 0.9304 | 1.7 | 13.8 | 4.0 | 95.0 | 1.0 | 13.5 | 71.0 | 15.5 |
| −5 | 1 | 0.9946 | 3.4 | 9.8 | 1.4 | 95.7 | 2.9 | 11.1 | 73.8 | 15.1 |
| −7 | 2 | 1.6861 | 2.4 | 16.6 | 2.1 | — | — | 13.5 | 71.3 | 15.2 |
| 1− | 0 | 0.4733 | 2.9 | 7.9 | 1.3 | — | — | 13.0 | 71.8 | 15.2 |
| 2− | 2 | 0.6392 | 5.0 | 8.2 | 1.3 | — | — | 12.2 | 72.3 | 15.5 |
| 4− | 1 | 0.8850 | 2.7 | 12.8 | 2.2 | — | — | 11.8 | 72.3 | 15.9 |
| 5− | 1 | 0.9937 | 2.8 | 18.0 | 2.5 | 95.2 | 2.3 | 12.9 | 71.8 | 15.3 |
| 6− | 1 | 1.8661 | 3.5 | 16.6 | 2.8 | 95.4 | 1.8 | 11.8 | 72.2 | 16.0 |
| +2 | 2 | 0.7028 | 2.3 | 8.1 | 1.7 | — | — | 14.4 | 69.8 | 15.8 |
| +3 | 3 | 0.9937 | 2.8 | 17.9 | 1.5 | 96.5 | 2.0 | 14.3 | 65.6 | 20.1 |
| +4 | 3 | 0.8129 | 3.4 | 11.9 | 1.8 | 96.9 | 1.3 | 13.2 | 69.8 | 17.0 |
| +6 | 2 | 1.8109 | 5.3 | 16.6 | 2.7 | 95.3 | 2.0 | 12.3 | 72.4 | 15.3 |
| 2+ | 1 | 0.6380 | 2.7 | 7.7 | 1.8 | — | — | 13.9 | 70.3 | 15.8 |
| 3+ | 1 | 1.0786 | 4.6 | 15.6 | — | — | — | 12.9 | 70.8 | 16.3 |
| 4+ | 1 | 0.9295 | 0.3 | 23.4 | 5.0 | 93.3 | 1.7 | 14.9 | 70.2 | 14.9 |
| 7+ | 2 | 1.3063 | 2.7 | 19.5 | 1.5 | 96.3 | 2.2 | 13.0 | 70.4 | 16.6 |
| 8+ | 3 | 1.0142 | 4.4 | 11.7 | 2.8 | 97.0 | 0.2 | 13.7 | 68.7 | 17.6 |
| Averages | 1.4 | 0.9949 | 3.3 | 13.0 | 2.2 | 95.7 | 1.7 | 12.9 | 71.0 | 16.0 |
| | | | | B: C. L., aged 21 | | | | | | |
| −1 | 1 | 0.4125 | 3.7 | 5.1 | 2.0 | — | — | 13.9 | 70.1 | 16.0 |
| −2 | 1 | 0.6148 | 8.7 | 4.4 | 1.0 | — | — | 14.1 | 68.9 | 17.0 |
| −3 | 2 | 1.2261 | 9.0 | 3.9 | 1.5 | — | — | 13.7 | 67.4 | 18.9 |
| −4 | 2 | 0.8430 | 6.2 | 6.3 | 2.3 | — | — | 13.4 | 70.5 | 16.1 |
| −8 | 1 | 2.7565 | 6.3 | 20.0 | 2.6 | — | — | 11.9 | 71.6 | 16.3 |
| 2− | 2 | 0.4239 | 5.1 | 1.5 | — | — | — | 15.5 | 66.2 | 18.3 |
| 3− | 1 | 1.0663 | 6.6 | 2.8 | — | — | — | 13.7 | 68.0 | 18.4 |
| 4− | 2 | 0.7083 | 5.5 | 5.9 | 1.4 | — | — | 13.2 | 69.7 | 17.1 |
| 5− | 2 | 1.1146 | 6.3 | 14.7 | 1.8 | 96.2 | 2.0 | 12.2 | 72.4 | 15.5 |
| 6− | 3 | 1.2352 | 6.1 | 1.1 | — | — | — | 14.1 | 61.3 | 24.6 |
| 8− | 0 | 2.8734 | 24.1 | — | — | — | — | 10.8 | 66.0 | 23.2 |
| +1 | 3 | 0.6143 | 6.5 | 2.0 | — | — | — | 14.5 | — | — |
| +3 | 2 | 1.1265 | 6.9 | 3.0 | 2.1 | — | — | 13.7 | — | — |
| +4 | 3 | 1.3066 | 21.9 | — | — | — | — | 12.9 | 69.5 | 17.6 |
| +7 | 1 | 2 5719 | 18.8 | 19.6 | 2.4 | 97.0 | 0.6 | 12.3 | 71.2 | 16.5 |
| 3+ | 1 | 1.3532 | 6.0 | 6.5 | 1.6 | — | — | 13.8 | 68.9 | 17.3 |
| 7+ | 2 | 2.6740 | 5.2 | 17.1 | 2.9 | 95.5 | 1.6 | 12.0 | 70.2 | 17.8 |
| 8+ | 1 | 2.2917 | 7.0 | 19.9 | 3.1 | 96.1 | 0.9 | 11.8− | 72.5 | 15.8 |
| Averages | 1.7 | 1 3451 | 7.1 | 8.3 | 2.1 | 96.2 | 1.3 | 13.2 | 69.0 | 17.9 |
| | | | | C: J. L., aged 17 | | | | | | |
| −1 | 3 | 0.3637 | 3.1 | 3.0 | — | — | — | 13.1 | — | — |
| −2 | 1 | 0.4230 | 8.9 | 1.5 | — | — | — | — | — | — |
| −3 | 3 | 0.8010 | 8.8 | 1.8 | — | — | — | 13.1 | 68.0 | 18.9 |

*Blanks in the enamel and dentin analyses were due to lack of sufficient material. The four blanks in the enamel percentage column were due to accidental loss.

(Continued on next page)

TABLE 3.—COMPLETE DATA ON ANALYSIS OF SEPARATED ENAMEL AND DENTIN (Continued)

| Tooth Position | Caries Class | Moist Weight of Whole Tooth | Tooth Loss During Separation | Enamel Per Cent | Enamel Moist Weight Moisture Per Cent | Enamel Moist Weight Inorganic Per Cent | Enamel Moist Weight Organic Per Cent | Dentin Moist Weight Moisture Per Cent | Dentin Moist Weight Inorganic Per Cent | Dentin Moist Weight Organic Per Cent |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | C: J. L., aged 17 (Continued) | | | | | | |
| −4 | 1 | 0.7996 | 10.1 | 6.1 | 2.7 | — | — | — | — | — |
| −5 | 2 | 1.1594 | 5.9 | 19.3 | 3.7 | 94.9 | 1.4 | 12.8 | 69.6 | 17.6 |
| −6 | 3 | 1.2877 | 8.8 | 0.1 | — | — | — | 13.2 | 65.6 | 21.1 |
| 1− | 3 | 0.3917 | 5.4 | 1.8 | — | — | — | 15.7 | 64.0 | 20.3 |
| 2− | 3 | 0.4399 | 2.8 | 2.7 | — | — | — | 15.6 | 64.6 | 19.8 |
| 3− | 3 | 0.8972 | 7.1 | 1.7 | — | — | — | 13.3 | 67.3 | 19.4 |
| 4− | 2 | 0.9072 | 7.8 | 11.4 | 2.1 | — | — | 13.1 | 69.6 | 17.3 |
| 5− | 1 | 1.1643 | 8.1 | 17.0 | 1.5 | — | — | 12.2 | 69.0 | 18.0 |
| 6− | 2 | 1.2823 | 7.4 | | — | — | — | 13.9 | 66.7 | 19.4 |
| 8− | 0 | 1.9151 | 7.4 | 20.4 | 1.6 | 93.6 | 4.8 | 12.6 | 70.4 | 17.0 |
| +3 | 0 | 0.9130 | 8.9 | 6.4 | 2.1 | — | — | 12.9 | 71.2 | 15.9 |
| +5 | 3 | 0.9293 | 8.1 | 14.1 | 3.2 | 95.2 | 1.5 | 13.8 | 68.2 | 18.0 |
| +6 | 2 | 1.2687 | 11.0 | 0.1 | — | — | — | 14.7 | 66.0 | 19.3 |
| +7 | 2 | 1.8610 | 9.6 | 17.2 | 2.1 | 96.8 | 1.1 | 12.6 | 68.6 | 18.8 |
| +8 | 0 | 1.2914 | 10.2 | 24.0 | 3.5 | 95.2 | 1.3 | 12.2 | 70.6 | 17.2 |
| 3+ | 3 | 0.9491 | 10.6 | 3.2 | — | — | — | 13.2 | 68.6 | 18.2 |
| 4+ | 3 | 0.8575 | 5.0 | 12.4 | 3.1 | 94.6 | 2.3 | 14.1 | 66.4 | 19.5 |
| 5+ | 3 | 0.6436 | 3.7 | 1.5 | — | — | — | 14.1 | 66.0 | 19.9 |
| 6+ | 3 | 1.4468 | 8.5 | 2.1 | — | — | — | 13.7 | 67.3 | 19.0 |
| 8+ | 3 | 2.4267 | 10.9 | 17.0 | 2.9 | 96.2 | 0.9 | 11.9 | 67.5 | 20.5 |
| Averages | 2.1 | 1.0617 | 7.7 | 8.4 | 2.6 | 95.2 | 1.9 | 13.4 | 67.7 | 18.7 |

the varying and small number of teeth in some of the groups.

Totaling the average values for the three constituents of enamel gives 99.6 per cent. The difference from 100 per cent is due to the small number of inorganic-organic determinations. The inorganic percentage of enamel is the most constant value of all those cited above. The organic percentage must be understood as the maximum value since there is included within the figure the small but definite amount of inorganic salts which are dissolved by the alkaline glycol.

There is also a fall in the average inorganic percentage of dentin in the more carious teeth from the same mouth. The average ash percentage for E. R. remains practically constant from Class 0 to Class 2 caries, then falls sharply. The three averages from C. L. progressively diminish with the increasing advance of caries. Patient J. L. has a stepwise fall in inorganic percentage with increasing caries throughout the four classes. Considering all the teeth, there is a fall of about 4.5 per cent in absolute inorganic percentage from Class 0 to Class 3 teeth.

No obvious relation between patients or caries groups is found in the inorganic percentage of enamel, shown in Figure 3. Since the ashing procedure will not analyze samples less than 100 mg. with sufficient accuracy, there were only seventeen values obtainable, and these show fairly wide variation.

*Moisture Content.*—In Figure 4, showing a similar comparison of the moisture content of dentin, there is such a scatter of points that probably little significance can be attached to the averages. There is no demonstrable difference between patients, but there is a slight increase (approximately 1 per cent absolute, but 8

per cent of the water present) of moisture content in Class 3 teeth when compared with the non-carious teeth, Class 0.

There is again no relation between the moisture content of enamel, shown in Figure 5, and either the caries group or the class of caries, although thirty-two values were obtained. Hence, the presence of decay in one portion of the enamel probably does not affect the moisture and inorganic percentages of the remaining enamel.

*Organic Percentage.*—The results reported in Figure 6, the organic percentage of dentin, are obtained by difference; i.e., addition of the moisture and inorganic percentages and subtraction from 100. Were it not for the fact that the values show even less scatter than those for water and inorganic contents, it would have been considered inadvisable to present them separately. The figure shows practically the inverse of findings on the inorganic percentage of dentin. There is a rise of organic content both with the classes from the least caries to the most severe caries, and with the patient from the least carious to the most carious mouth. In all caries classes, the teeth of J. L. show higher average organic percentage than those of E. R., and in Classes 1 and 2, the three patients show stepwise increase. There is also an increase from class to class, with an approximate value of 16 per cent organic for Class 0 teeth, and 19.5 per cent for the teeth in Class 3, a difference of 3.5 per cent absolute, or 20 per cent of the organic material present.

The values for the organic percentage of enamel ranged from 0.6 to 2.9 per cent, with an average of 1.8 per cent. These were determined by difference as in the case of dentin, and no correlation with the extent of caries was found.

TABLE 4.—AVERAGE VALUES AND EXTREME VARIATIONS

| | Enamel | | | Dentin | | |
|---|---|---|---|---|---|---|
| | Average | Maximum | Minimum | Average | Maximum | Minimum |
| Moisture | 2.3 | 5.0 | 1.0 | 13.2 | 15.7 | 10.8 |
| Inorganic | 95.6 | 97.0 | 93.3 | 69.3 | 73.8 | 61.3 |
| Organic | 1.7 | 4.8 | 0.2 | 17.5 | 24.6 | 15.1 |

TABLE 5.—ANALYTIC RESULTS ON FOUR TEETH FROM PATIENT F. C.

| Tooth Position | Caries Class | Dentin Analysis | | |
|---|---|---|---|---|
| | | Water | Inorganic | Organic |
| | | Per Cent | Per Cent | Per Cent |
| Upper left 3 | 0 | 12.43 | 73.06 | 14.51 |
| Upper right 1 | I | 13.15 (2) | 70.58 (2) | 16.28 (2) |
| 3 | | | | |
| Upper right 2 | II | 13.46 | 70.31 | 16.23 |

Some additional evidence of the differences in inorganic, moisture and organic percentages from Class 0 to Class 2 caries is given in Table 5. Four teeth were obtained from a fourth patient, F. C. There are found stepwise changes of composition —a 1 per cent increase in moisture, 2.7 per cent decrease in inorganic percentage and 1.5 per cent increase in organic percentage from Class 0 to Class 2 caries.

## COMMENT

The two methods reported in conjunction with the procedure for the separation of enamel from dentin possess certain advantages:

1. Analyses may be made on all the

enamel and dentin from a single tooth with a known degree of purity for the separated tissues.

2. Determination of the percentage of enamel obtained is important, when normals have been found, for evaluating the extent of attrition or caries.

3. The determination of moisture is rapid, simple and apparently fairly accurate. The procedure eliminates water included in the pulp from the results of the analysis. Pulpal material is lost in the process of separation.

4. Determination of the inorganic percentage is accurate and fairly rapid. This modification of the Gabriel ash procedure has the latter's advantage in producing a white ash on which calcium, phosphorus and magnesium determinations may be made.

The procedure for the determination of moisture is untested and as yet there is no way to check its validity other than by comparison with the values obtained on whole teeth. When the moisture contents of enamel and dentin from the same tooth are multiplied by the respective percentages of the enamel and dentin, the sum of the products is the calculated value for moisture of the whole tooth. This calculated value for whole tooth moisture was determined for twenty teeth selected at random from the series reported and found to average 11.95 per cent. The highest of the twenty values was 14.21 and the lowest 9.90 per cent. These calculated values are higher than the range 6.91 to 8.76 per cent, average 8.01 per cent, found by Gassmann for the moisture content of whole sound teeth, and higher than the average 8.34 per cent found by one of us (R.S.M.) for eleven air-dried whole sound teeth. The higher calculated values may be due both to the removal of more water by the vacuum drying process employed by us and to the fact that a comparison is being made between carious and non-carious whole teeth.

Although a number of investigations have given isolated data on the water, inorganic or organic content of enamel or dentin, only a few have given each of these components for both tissues. Furthermore, the data have always been reported on samples of enamel or dentin and not on all of the enamel and dentin from a single tooth. Consequently, the data of Table 3 acquire a certain unique interest. If the available data[6, 7] from the literature are condensed, the following tabulation offers an approximation of the constitution:

| | Water | Inorganic | Organic |
|---|---|---|---|
| Enamel | 1.5 | 92 | 6.5 |
| Dentin | 9 | 66 | 25 |

In comparison, the values in Table 4 show higher inorganic contents for both enamel and dentin with correspondingly lower organic percentages. The water content for enamel is not greatly different, but for dentin is appreciably higher. These differences may be due to the differences in materials analyzed or to the refinements in technic, such as use of *in vacuo* drying. The average values in Table 3 should not be taken to represent "normal" values. Many more determinations are needed to establish the normals.

The interpretation of the results must be made with caution. The contrast between patients—greater organic and lesser inorganic percentage in the dentin with increasing extent of caries—could possibly be due to chance, since there are only three patients available for comparison. It would require study of several more patients to establish this difference as statistically real. If the difference is characteristic of the extent of caries in the mouth, there is still the question whether the change is one of cause or effect. There is the possibility that the connection is causal; i.e., a lower inorganic percentage in the dentin predisposes to caries. Alternately, the relation may be one of effect; i.e., a carious condition of a large number of the teeth brings about a systemic or salivary decalcification of the dentin of the non-carious teeth in the same mouth.

The differences between the teeth of single patients are more firmly established. The more carious teeth in the same mouth show about 3.5 per cent greater organic and 1 per cent higher moisture, but 4.5 per cent lower inorganic material in absolute percentage. The most obvious assumption for explanation of these facts is the greater inorganic content of the crown dentin. Black (1895)[8] states that "the dentine of the crown of a tooth is generally heavier in proportion to its bulk, is more dense, than the dentine of the root; this difference in relative density averaging about twenty-five thousandths of a volume." Since density and inorganic percentage conceivably are covariant, there is probably a higher ash content in the crown than in the root dentin. Since our preliminary removal of carious material would generally consist in removing crown dentin, it would be expected that the average calcification values for all of the dentin would be lower the more of the crown there was involved in caries. The loss of the more highly calcified crown dentin would leave a dentin with a smaller inorganic percentage. Comparative determinations on the inorganic and organic percentages of root and crown dentin should be made. If such determinations do not quantitatively account for the differences, some other assumption will be necessary. In such case, the relation might either be causal, in the sense of a predisposition, or resultant, in that the advance of caries in a single tooth produces a slight decalcification of the non-carious dentin.

## SUMMARY

1. Determinations were made on the percentage of moisture and inorganic material on separated enamel and dentin of sixty-five teeth from four patients, with the possibility of correlating these values with the extent of caries. Moisture was determined by a new procedure and inorganic percentage by a modified Gabriel ash method.

2. Enamel analyses (moist weight basis) on all the teeth gave averages of 2.3 per cent for moisture, 95.6 per cent for inorganic and 1.7 per cent for organic content (by difference). Dentin from all the teeth was found to average: moisture, 13.2 per cent; inorganic, 69.3 per cent, and organic (by difference), 17.5 per cent.

3. When the teeth from any one patient were classed according to an increasing extent of caries, the averages of the moisture and organic percentages of dentin were progressively greater. The inorganic percentage was progressively less.

4. Within single caries classes, the teeth from three patients were grouped according to the extent of caries in the mouth. The dentin analyses then showed decreased inorganic, increased organic and unchanged water percentage in going from the least to the most carious mouth.

5. No correlation could be found between the enamel analyses and the extent of caries.

## BIBLIOGRAPHY

1. Crowell, C. D.; Hodge, H. C., and Line, W. R.: *J. D. Res.*, 14:251, August 1934.

2. LeFevre, Marian L., and Hodge, H. C.: *J. D. Res.*, to be published.

3. Manly, R. S., and Hodge, H. C., to be published.

4. Bowes, J. H., and Murray, M. M.: *Biochem. J.*, 29:2721, December 1935.

5. Murray, M. M., and Bowes, J. H.: *Brit. D. J.*, 61:473, October 1, 1936.

6. Bertz, F.: *Jahresb. über d. Fortschr. d. Thierchem.*, 30:457, 1900.

7. Kühns, C.: *D. Monatschr. f. Zahnheilk.*, 13:450, 1895.

8. Black, G. V.: *D. Cosmos*, 37:353, May 1895.

# MODERN DENTURE BASE MATERIALS, AND WHAT TO EXPECT OF THEM*

By HORTON D. KIMBALL, D.D.Sc., Detroit, Mich.

A GREAT amount of work has been done by various investigators on the physical properties of denture base materials. In many of the reports published to date, a large portion of this work has been so highly technical as to be most difficult for many dentists to interpret. As a result, there still exists in the minds of these dentists considerable question as to the relative merits, the advantages and the disadvantages of the different denture materials on the market today.

It is the purpose of this paper, therefore, to clarify this condition, and to give a practical interpretation to the data obtained from laboratory tests.

One of the questions most frequently asked by the average dentist is, "What is the best denture material?" This is a difficult question to answer, for it depends upon what is meant by the word "best." It may vary with different individuals. For instance, one man may desire a strong base material; another, one with a pleasing color; while still another may prefer one which is unlikely to warp, etc. Thus, what is "best" to one man is not to another. And that is one reason why it has proved so difficult and so tedious to draw up adequate specifications for denture materials.

It was thought that some information of value might be obtained if it were possible to determine which denture materials are most commonly used by dentists; which ones have proved most successful, and the principal objections to the various materials.

With this thought in mind, the writer sent a questionnaire to one hundred commercial dental laboratories in different parts of the country, covering thirty-five states. The results of the questionnaire were most interesting. It was found that of all the full dentures made 70 to 75 per cent are still made of vulcanite; 15 to 20 per cent are made of condensites (phenol-formaldehyde resins of the Bakelite type); 8 per cent of the cellulose group, and 1 per cent of vinylites. (Table 1.) From the results summarized in Table 1, it is apparent that vulcanite is still the most popular of all denture materials.

The principal objections to the so-called vulcanite substitutes were listed by the laboratories as follows:

Condensites fade, are difficult to manipulate, break easily, and are difficult to repair.

Vinylites break and are difficult to repair.

Cellulose products warp, fade, and are difficult to repair.

As has been stated before, up to the present time, no standard requirements or specifications have been brought forth for denture materials, although it is understood that the Bureau of Standards has a tentative set of specifications which is nearing completion.

An attempt has been made by the writer to correlate and to combine work that has been done by others in this field,

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*Tests made in Physical Testing Laboratories, University of Michigan, College of Dentistry.

along with his own experiences and findings on the subject, into a suggested outline of requirements for an ideal denture material.

This outline is not wholly original. Neither is it intended to be mandatory in its form, for the listed requirements and the order of their importance is arbitrary and may be open to question. It is believed, however, that an outline of this nature, along with a practical interpretation of the suggested requirements may prove of some interest and value to the average general practitioner. Accordingly, the outline as shown in Table 2 is presented.

by him in a previous report, though it is now revised and brought up to date. In this outline, a slight question exists as to the identity of a few materials, and the manufacturer's word is accepted as the authority in these cases.

Table 3 presents this revised outline. It is interesting to note the large number of materials having different trade names, yet having essentially the same basic chemical nature.

The words "thermoplastic" and "thermosetting" have been defined before and are perhaps familiar to most dentists. For the sake of completeness, however, it may be well to briefly discuss the terms. All

TABLE 1.—RELATIONSHIP BETWEEN AMOUNTS OF VARIOUS BASE MATERIALS USED IN FULL DENTURE CONSTRUCTION*

| Material | Range | Average |
|---|---|---|
| 1. Vulcanite | 35%—90% | 71% |
| 2. Phenol Formaldehyde Resins | 5%—50% | 20% |
| 3. Cellulose Products | 0%—35% | 8% |
| 4. Vinyl Resins | 0%—8% | 1% |

OBJECTIONS TO VULCANITE SUBSTITUTES

1. Vinyl Resins:
   Breakage, and poor reparability.
2. Cellulose Products:
   Warping, fading, porosity, and poor reparability.
3. Phenol Formaldehyde Resins:
   Fading, breakage, and poor reparability.

*Data compiled from questionnaire sent to 100 commercial laboratories in thirty-five different states.

These requirements will be discussed point by point later in this paper. First, however, the thought arises that much confusion must exist in the minds of many men as to the identity of these various denture materials, and as to just what their nature may be.

Dr. Nelson has, in his report, discussed in great detail the chemical properties of our modern denture bases. At the risk of repeating, however, the writer is presenting a diagrammatic outline of the various materials, showing their basic nature and their relation to one and another. This outline is similar to one used

non-metallic denture base materials are divided into two large groups, i.e., thermosetting and thermoplastic.

The word "thermosetting," as its name indicates, denotes a material which hardens or "sets" upon the application of heat of the proper nature (as in a vulcanizer). During the process of hardening, an irreversible chemical reaction takes place, so that the material once used cannot be used over again.

The thermosetting base materials are divided into two main groups: Vulcanite, with which all are familiar, and Synthetic Resins.

The thermosetting synthetic resins are in turn subdivided into two groups, viz., the Glyptal type, and the Bakelite type.

The Glyptal type are condensation products of Glycerol and Phthallic anhydride; while the Bakelite type are condensation products of Phenol and Formaldehyde. It is the Bakelite type which provides the greatest amount of vulcanite substitutes used at the present time.

The word "thermoplastic" denotes a material which softens and becomes plastic upon application of heat. When it is in this plastic state, it can be molded or pressed into the desired form. Upon removal of heat, it hardens into its newly acquired form. No chemical reaction is associated with the pressing or molding process, and the material may, upon being reheated, be re-pressed and used again, with more or less success.

TABLE 2.—REQUIREMENTS FOR AN IDEAL PLASTIC DENTURE BASE MATERIAL

1. Tissue Tolerance.
2. Absence of Objectionable Taste and Odor.
3. Strength:
   a. Flexure-Fatigue.
   b. Impact Strength.
   c. Transverse Strength.
4. Dimensional Stability (Warpage).
5. Volumetric Stability (Absorption).
6. Pleasing and Permanent Color.
7. Accuracy of Reproduction of Original Pattern.
8. Simplicity of Manipulation and Cure.
9. Ease and Success of Repair.
10. Weight.
11. Thermal Conductivity.

The thermoplastic base materials are divided into several groups, viz., cellulose products, glass, and synthetic resins.

The cellulose products are in turn subdivided into cellulose nitrates and cellulose acetates. The cellulose nitrates comprise practically all the cellulose base materials in use today. Cellulose acetate has, for the most part, proved unsatisfactory for denture purposes. Attempts have been made to produce a denture material by combining the cellulose nitrate and acetate, but have not proved particularly successful.

Glass is here mentioned more as a point of interest, for it is still in the experimental stages. To be sure, it has much in its favor, although the results seen thus far by the author have been quite disappointing. It is too early, however, to form a definite opinion one way or the other.

The thermoplastic synthetic resins are in turn subdivided into four groups, viz., the Vinylite type, the Polystyrol type, the Aralkyl-Halide type and the Acrylate type.

The Vinylite type is composed of polymerized vinyl esters, i.e., vinyl acetate and vinyl chloride. Two or three years ago, this group was tremendously popular. However, so many dentures broke while in use in the mouth, that this type has fallen into extreme disfavor.

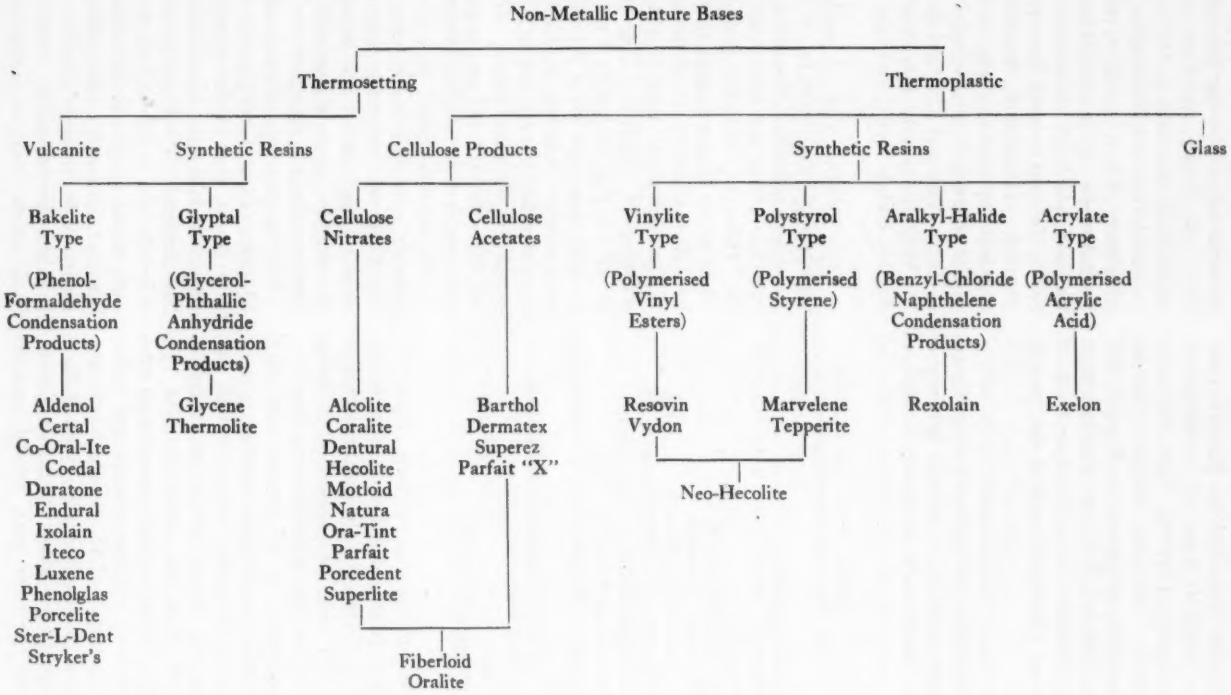
The Polystyrol type is composed of polymerised styrene. This particular group was represented by a material two or three years ago which proved very unsatisfactory. Another material of the same type has recently been placed on the market by the same people. Whether or not this substance will prove successful is open to question. It is too soon to be sure.

The Aralkyl-Halide type is a benzyl-chloride, naphthalene condensation product. There was but one material marketed in this group, and it was removed from the market about six months ago. It proved quite unsatisfactory.

The Acrylate type is composed basically of polymerised acrylic acid. This is a new group, and at the present time is represented by one commercial denture base material. Much experimental work is being done in this group, and it is too early to pass judgment upon it as a whole. Some of the acrylic acid resins are often spoken of as "organic glass."

In this discussion, two terms have been used which may necessitate more ex-

TABLE 3.—CLASSIFICATION OF DIFFERENT TYPES OF DENTURE MATERIALS



planation, viz., "condensation," and "polymerization." Once more, for the sake of completeness, it may be well to briefly define the terms. A textbook on organic chemistry[1] states, "By *condensation* is meant the union of two or more of the same or different molecules, with the elimination of water or some other inorganic compound."

Compounds which have the same percentage composition, but different molecular weights are *polymers*. Thus, benzene, $C_6H_6$, is a polymer of acetylene $C_2H_2$, and *polymerization* refers to the act of synthesizing a *polymer*.

It is hoped that this hurried résumé may help to fix in the minds of the dentists some of the various chemical properties and natures of the different denture materials.

With regard to the outline of requirements for denture materials, an attempt has been made to list them in the order of their importance. This is an arbitrary arrangement, and may not meet with the approval of all minds. In the discussion of the various materials and their merits in regard to the requirements, only the four most commonly used groups will be considered, viz., vulcanite, phenol-formaldehyde (Bakelite) resins, cellulose products, and vinyl resins.

1. *Tissue Tolerance:*

It was felt that in order to be even considered for use in the mouth, a material must have tissue tolerance.

Clinical evidence shows that, in general, all base materials on the market today possess this quality. There are occasional individual exceptions perhaps.

CHART I.—PHYSICAL PROPERTIES OF DENTURE MATERIALS*

| Material | Flexure Fatigue | Average Number of Flexures |
|---|---|---|
| Metal-filled Base Vulcanite | "A" | |
| Brown Base Vulcanite | "B" † | |
| Cellulose Nitrate | "C" | 10,000,000 |
| Cellulose Nitrate | "D" | |
| Phenol-Formaldehyde Resin | "E" | |
| Phenol-Formaldehyde Resin | "F" | 7,841,000 |
| Phenol-Formaldehyde Resin | "G" | 7,000,000 |
| Vinyl Resin | "H" | 1,495,000 |
| Vinyl Resin | "I" | 500,000 |
| Phenol-Formaldehyde Resin | "J" | 360,000 |
| Phenol-Formaldehyde Resin | "K" | 356,000 |
| Pink Base Vulcanite | "L" | 270,000 |
| Phenol-Formaldehyde Resin | "M" | 67,100 |
| Phenol-Formaldehyde Resin | "N" | 20,420 |
| Phenol-Formaldehyde Resin | "O" | 5,654 |

*Relative fatigue values for base materials.
†Specimens remained unbroken after 10,000,000 flexures.

The so-called "rubber-sore" mouth is a rarity; and although vulcanite is an insulating material and tends to produce a mild hyperemia, the tissues seem to tolerate it quite readily.

The presence of too much camphor as a plasticizing agent in some of the cellulose materials will produce a tissue reaction. The average cellulose denture is, however, quite kind to mouth tissues.

The bakelite type is very readily tolerated by the oral tissues. In fact, many believe these to be the most favorable from the standpoint of tissue tolerance.

The vinyl resins meet this requirement quite readily.

2. *Absence of Objectionable Taste and Odor:*

Here again, a material must possess these qualities before being considered for use in the mouth.

Vulcanite meets this requirement, except in an improperly cured case.

Cellulose products sometimes have an objectionable camphor taste and odor, although in general, they too fulfil this requirement.

The phenolic resins in a properly cured case have no objectionable taste or odor.

The vinyl resins are tasteless and odorless.

3. *Strength:*

The question of strength is paramount in the minds of most men. There are many forms of strength, however, and it is difficult to decide what kind of strength is most desirable.

The author has done a great deal of research work upon this subject, and has published his findings in previous reports.[2,3] At that time, six forms of strength and strength tests were considered, viz., hardness; modulus of elasticity; tensile-strength; flexure-fatigue; impact-strength, and transverse-strength.

After careful consideration, the first three mentioned strength tests have been discarded in an effort to simplify the procedure for testing materials. It may prove necessary, however, sometime in the future to employ these tests once again. It was felt that hardness was relatively unimportant as a specific test, for it was incorporated to a certain degree in the other suggested requirements.

Modulus of elasticity, or stiffness, was also discarded as a specific test, for it is incorporated in both flexure-fatigue and transverse strength.

Tensile strength test is the most commonly used method of testing strength of materials, and perhaps it is wrong to discard this test completely. It is, however, a most misleading test. For instance, the vinyl resins possess a tremendously high tensile strength, and yet have to date

CHART II.—PHYSICAL PROPERTIES OF DENTURE MATERIALS*

| Material | Impact Strength | Average Impact Strength (Inch pounds per inch) |
|---|---|---|
| Vinyl Resin | "H" | |
| Cellulose Nitrate | "C" † | |
| Cellulose Nitrate | "D" | 450.0 |
| Metal-filled Base Vulcanite | "A" | 349.0 |
| Brown Base Vulcanite | "B" | 95.6 |
| Vinyl Resin | "I" | 71.5 |
| Pink Base Vulcanite | "L" | 36.8 |
| Phenol-Formaldehyde Resin | "F" | 29.8 |
| Phenol-Formaldehyde Resin | "G" | 27.3 |
| Phenol-Formaldehyde Resin | "E" | 25.5 |
| Phenol-Formaldehyde Resin | "J" | 17.3 |
| Phenol-Formaldehyde Resin | "N" | 16.1 |
| Phenol-Formaldehyde Resin | "K" | 15.5 |
| Phenol-Formaldehyde Resin | "O" | 12.5 |
| Phenol-Formaldehyde Resin | "M" | 7.0 |

*Relative impact strength of base materials.
†Specimens would not break in machine.

proved decidedly unsatisfactory for use as denture materials. For this reason it was felt advisable to discard, at least temporarily, tensile strength tests.

The remaining three strength tests, i.e., flexure-fatigue, impact strength and transverse strength, have been found to furnish adequate information as to the strength properties of the various materials.

Flexure-fatigue may be considered as a measure of the "life" of the material. It consists of simply bending a specimen back and forth through a given arc until it breaks. We have all had occasion to bend a piece of wire in this fashion until it became fatigued and broke.

A denture in the mouth receives this same type of stress. When an individual bites, the stress applied on the teeth bends or flexes the case along the region of the mid-line of the palate; and when the biting pressure is released, the denture returns to its original form. It has been estimated that an individual bites approximately half a million times per year. Thus, one may readily see the extreme practical value and importance of this test, and the necessity for having a material which will have a high flexure-fatigue value.

The machines and the technical procedure used in making this and the two remaining strength tests have been described in previous reports.[2,3]

Flexure-fatigue tests have been run on a representative group of the more commonly used denture materials. In these tests, after 10,000,000 flexures the machine was stopped. That is the theoretical equivalent of twenty years' wear, and is sufficient to gain a clear comparison of the various materials. The results of these tests are shown in Chart I.

It will be seen that two of the vulcanites remained unbroken after 10,000,000 flexures. The third one, a pink base vulcanite, broke after but 250,000 flexures. This, perhaps, may be explained by the high percentage of pure rubber in the

CHART III.—PHYSICAL PROPERTIES OF DENTURE MATERIALS*

| Material | | Transverse Strength Deflection (Inches) | Transverse Strength (Lbs. per sq. in.) |
|---|---|---|---|
| Vinyl Resin | "H" † | 0.206 | 16,735 |
| Vinyl Resin | "I" † | 0.192 | 16,460 |
| Phenol-Formaldehyde Resin | "E" | 0.094 | 13,030 |
| Phenol-Formaldehyde Resin | "G" | 0.092 | 12,715 |
| Metal-Filled Base Vulcanite | "A" † | 0.298 | 12,545 |
| Brown Base Vulcanite | "B" | 0.297 | 11,883 |
| Phenol-Formaldehyde Resin | "J" | 0.080 | 11,705 |
| Phenol-Formaldehyde Resin | "N" | 0.081 | 11,702 |
| Phenol-Formaldehyde Resin | "K" | 0.086 | 10,300 |
| Pink Base Vulcanite | "L" | 0.069 | 8,633 |
| Phenol-Formaldehyde Resin | "F" | 0.075 | 7,919 |
| Cellulose Nitrate | "D" † | 0.179 | 6,938 |
| Phenol-Formaldehyde Resin | "O" | 0.048 | 6,028 |
| Cellulose Nitrate | "C" † | 0.180 | 5,925 |
| Phenol-Formaldehyde Resin | "M" | 0.127 | 2,150 |

*Relative transverse strength of denture base materials.
†Specimens did not break in machine.

first two, and the fact that the pink base vulcanite has more filler and less pure rubber in it.

It is of interest to note that one of the phenol resins also remained unbroken after 10,000,000 flexures, and two of the others averaged over 7,000,000 flexures before breaking. The remainder of the group fell much lower on the scale.

The cellulose materials will also be seen to possess a very high fatigue value, as they too remained unbroken after 10,000,000 flexures.

The vinyl resins were found to be poor with respect to flexure-fatigue. They averaged less than a theoretical three years' wear, and some specimens broke even more quickly. It is possible that this may account in part for the vinyl resins having been so unsatisfactory as denture materials. It will be recalled that the greatest objection to them was the fact that they broke so often while actually in use in the mouth.

Impact strength is a measure of the brittleness of the material. It might be compared to the shock received by a denture should it be dropped.

Chart II illustrates the comparative impact strength of the various materials tested.

The two base vulcanites "A" and "B" were found to possess a high degree of impact strength; while the third, the pink base vulcanite "C," was decidedly brittle. The metal filled base vulcanite had by far the greatest impact strength of the three.

The cellulose bases had a still higher impact value, and would not break in the machine.

One of the vinyl resins was also very strong in this respect, and would not break in the machine although the other vinyl resin did break.

The phenol resins, it will be seen, were all extremely brittle. That has been one of the principal objections to these materials. Many dentists feel they are too glass-like, and too apt to shatter.

Transverse-strength is more correctly termed "Flexural-strength," according to the latest A.S.T.M. standards. In the previous reports, the author has used the term flexural-strength, and has found that dentists frequently confused this with flexure-fatigue, thinking them to be synonymous. There is, however, no apparent relationship or connection of this nature between the two tests. To avoid such confusion, the older term "transverse-strength" has been employed in this present report.

Transverse-strength may be looked upon as a measure of the stiffness or "backbone" of a material. This is an essential property in a denture base, in order that the denture may retain its form after being fabricated.

The machine used in making this test records the distance a specimen bends up to the breaking point, and the force required to bend it. Thus, a measure of the flexibility of the material is also obtained.

Chart III illustrates the comparative flexibility and transverse-strength of the various materials tested.

The vinyl resins will be noted to have the highest transverse-strength of all, and would not break in the machine. They were extremely flexible, bending the full limit of the machine.

Certain of the phenol resins were found to possess a higher transverse strength than the two dark base vulcanites, while others were of nearly the same strength. Still others of this group were very weak in this respect. It is interesting to note, however, that in all cases the phenol resins had but a very slight degree of flexibility, as compared to the other materials.

The two dark base vulcanites had a high transverse-strength and a very high degree of flexibility. The metal filled rubber bent the limit of the machine without breaking. The pink base rubber was more comparable to some of the weaker phenol resins, both in strength and flexibility.

Neither of the cellulose nitrates would break in the machine. They were very flexible, and had a very low transverse-strength. This doubtless accounts in part for the tendency of cellulose dentures to warp.

By studying the charts, a clear picture is obtained of the comparative strength of one material to another. The Charts I, II, and III have been prepared according to scale, so that at a glance the relative strengths of the various materials may be seen. The different products have been lettered, and the same letters used opposite their respective product in all three charts.

It is evident from a study of these charts that a lack of uniformity exists in the materials. Thus, a substance with a high impact-strength and high transverse-strength shows poorly in respect to flexure-fatigue, as in the case of the vinyl resins. The cellulose materials, on the other hand, show well for fatigue and impact values, but are poor with regard to transverse strength.

It is readily seen, then, that no one or even two forms of strength are fully adequate for a denture material to have it fulfil the requirements of strength.

A material which will stand high in all three properties will be found stronger and less apt to break than other materials. This is quite evident when one considers the strength of the dark base vulcanites as compared with that of the other base materials.

The phenol resins are weak in impact strength and have proved objectionable to many for that reason.

4. *Dimensional Stability (Warpage):* This is another important property to be considered. A denture material should be stable in form and not warp. This condition must hold true not only at mouth temperature, but also at the temperature of hot liquids. Manufacturers of some of the phenol-formaldehyde resins have selected a temperature of 150°-160° F. as the "yield point" for their materials. This is a much hotter temperature than can be tolerated by the oral tissues. They feel that if the material does not warp below this temperature, it is safe for use. There is, however, a tendency for some of them to warp or flow very slowly at a temperature considerably below their "yield point." This would, of course, eventually affect the fit of the denture, and is a point to be borne in mind.

Work on the subject of dimensional stability has been done by the Bureau of Standards.[4] From the work done thus far by other workers, and from the data gathered to date by the writer, it appears that in general, the thermoplastic materials are more subject to the possibility of warpage than are the thermosetting bases. The vinyl resins, however, appear to be quite satisfactory in this respect, and warp less readily than certain of the phenolic group. Work is now in progress on this phase at the University of Michigan and will be reported upon completion.

5. *Volumetric Stability (Absorption):* Work done to date by the Bureau of Standards,[4] and that being done at the University of Michigan indicate that the cellulose nitrates are the most porous of the group. Surprising as it may seem, most of the phenolic resins also absorb considerable water. The vinyl resins are the least absorptive; while the vulcanites lie between the vinylites and the phenolic resins in their porosity.

6. *Pleasing and Permanent Color:* The problem of testing color is one that deserves much thought. At the present time, exposure to ultraviolet light is the most popular means for making these tests. This is not entirely satisfactory, as the results obtained in the laboratory do not always check with clinical results. Thus, under ultraviolet light, the vinyl resins are inclined to fade, while in the mouth, the color has held up very successfully.

One of the principal objections to the

phenol-formadelhyde resins has been their tendency to discolor. These materials will discolor under ultraviolet light as well as in the mouth. Certain of the phenolic products exhibit markedly superior color life to the others, although there is still room for much more improvement in them.

The cellulose materials are found to retain their color better under ultraviolet light than in the mouth.

Vulcanite has little tendency to fade under either condition. Much work still remains to be done on the subject of color tests.

7. *Accuracy of Reproduction of Original Pattern:*

For all practical purposes, all of the materials in use today reproduce the original pattern with a sufficient degree of accuracy. Vulcanite has perhaps the greatest degree of volume change, shrinking from 3 to 6 per cent.[4] The phenol resins reproduce the pattern most accurately. The vinylites, because of their low softening points, may be considered as being next in faithfulness of reproduction of original pattern. The cellulose products, while they have a higher softening point than vulcanite, reproduce the pattern more accurately because there is no volume change of the material itself. The adaptability of the oral tissues, however, apparently compensates largely for the discrepancy of the materials with regard to processing.

8. *Simplicity of Manipulation and Cure:*

The thermoplastic bases are to the majority of men the simplest to manipulate. Vulcanite also meets this requirement with ease, and is less sensitive to variations in curing temperature than any of the base materials. One of the principal objections to the phenolic bases is the difficult and complicated technic of their manipulation and cure.

9. *Ease and Success of Repair:*

The thermoplastic materials are comparatively easy to repair, but such a repair is not very successful as a rule. In fact, that is one of the principal objections to the vinylite and cellulose groups. Vulcanite readily fulfils this requirement. In general, with the exception of simple repairs, the phenolic resins cannot be repaired with a great degree of success or ease.

10. *Weight:*

All the commonly used materials are sufficiently light in weight for successful use in the mouth.

11. *Thermal Conductivity:*

In such thin sections as the palate of a denture, the thermal conductivity of the various materials is very similar, and for practical purposes, they may be considered as the same. Tests conducted by the Bureau of Standards[4] have shown this to be true.

It is hoped that a clarified mental picture has here been presented relative to the physical properties of the various modern denture base materials, and what results may be reasonably expected from their use.

It may now be clear why there is no "best" denture material. The "best" material may differ in various cases. One must first carefully study the particular case at hand; next, decide which physical properties are most essential to its success, and then use the base material most nearly fulfilling the desired requirements.

BIBLIOGRAPHY

1. Norris, J. F.: Principles of Organic Chemistry. New York City: McGraw Hill Book Company, 1922, pp. 19 and 200.

2. Kimball, H. D.: Determinations Regarding the Strength of Denture Materials: Vulcanite. J.A.D.A., 23:579, April 1936.

3. Kimball, H. D.: Further Determinations on the Strength of Denture Materials: Condensites and Vulcanites. J.A.D.A., 23:1904, October 1936.

4. Sweeney, W. T., and Schoonover, I. C.: A Progress Report on Denture Base Material. J.A.D.A., 23:1498, August 1936.

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# OSTEITIS FIBROSA AND ASSOCIATED LESIONS OF THE JAWS

By W. Harry Gullifer,* D.M.D., Boston, Mass.

CERTAIN connective tissue lesions of a benign nature occurring in the jaws are grouped variously under osteitis fibrosa and as ossifying fibroma and osteofibroma.

Osteitis fibrosa has been subjected to a meaning of considerable latitude, embracing the bone cyst, both acute and latent; generalized osteitis fibrosa, or osteitis fibrosa cystica, a multiple lesion due to parathyroid adenoma; benign giant-cell tumor in certain of its phases; the ossifying fibroma, or osteofibroma, and the spongy type of osteoma.

However, there are certain differences in these lesions which should be understood for proper differentiation.

### BONE CYST

The bone cyst of the jaw, which is found in patients from 5 to 20 years of age, is the result of trauma, usually in the form of a blow.

The mandible is the favorite site, and of the reported cases there is not a single instance of occurrence in the maxillae. The reason for this may be the lack of dense cortical bone in this region. Following trauma to cortical bone, there is an interference with normal blood supply which is compensated for by the formation of new capillary channels through the cancellous bone to the injured cortex, with marked benign giant-cell activity to make the new bony channels for such vessels.

Where cortical bone is as thin as it is in the upper jaw, it is conceivable that trauma may result in a benign giant-cell tumor rather than a bone cyst, or may cause fracture of the alveolar bone, thus preventing the bone cyst formation.

The outstanding symptom in the long bones is pathologic fracture sometime after the injury, due to expansion of the cyst; but in the jaws where swelling and moderate pain follow the injury, the patient usually seeks advice and the condition is discovered before fracture occurs.

The x-rays will reveal a homogeneously rarefied area of varying extent centrally located in the bone and of relatively smooth outline, and which bears no relationship to the teeth; that is, the teeth are usually vital to pulp test and of normal appearance in the x-ray film. If root-treated teeth or pulpless untreated teeth are present, the diagnosis may become complex, and final diagnosis must await the findings at operation together with the microscopic examination.

One very positive x-ray finding is the intact lamina dura which surrounds the root portion of the teeth adjacent to the bone cyst cavity.

The lesion is benign and does not extend beyond the cortex of the bone except at the point of fracture, if such a fracture occurs. There is uniform expansion of the cystic cavity without penetration of the cortex except, as spoken of previously, at the point of fracture.

This lesion should not be confused

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with the radicular cyst or root cyst which is concerned etiologically with the epithelial cells of the normal peridental membrane. The bone cyst is a connective tissue lesion.

When a bone cyst is opened, blood serum may be encountered or a thin serous fluid, together with fragments of connective tissue lining the bony cavity; or there may be no lining of connective tissue present.

Examination of the contents of the bone cyst microscopically will reveal the cyst wall of connective tissue, when such a structure is present, and fibroblasts which are differentiating into osteoblasts to form new bone in an effort to heal the cyst. In the early stages, there may be benign giant-cell activity, but as a rule these lesions are seen at a stage when osteoclastic activity has ceased and bone repair is in progress.

The bone cyst, therefore, is to be interpreted as the result of an injury in which there takes place in the early stages marked osteoclastic or benign giant-cell activity with bone resorption, followed by an arrest of the condition and an attempt at healing by bone repair, with resultant bone cyst formation.

The reason advanced for failure of complete spontaneous healing in these cases is Nature's inability to collapse the walls of the cyst.

The difference between the acute bone cyst and the latent bone cyst is one of time. If the acute condition is arrested spontaneously and remains undiscovered, after an extended period, the latent bone cyst develops.

Serum calcium and phosphorus are normal and the lesion is solitary, not multiple.

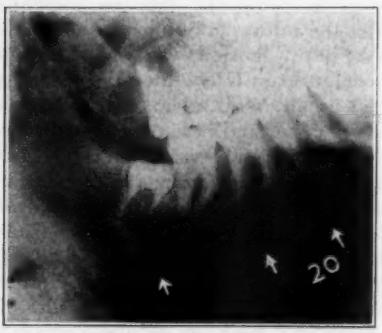


Fig. 1.—Traumatic bone cyst in mandible of 12-year-old girl, the condition resulting from a fall. The teeth are vital. (Case of Carl D. Lucas.)

Fig. 2.—Enlarged view of traumatic bone cyst, showing intact lamina dura around cuspid and bicuspids; a characteristic x-ray finding of diagnostic importance. The teeth are vital.

### LOCALIZED OSTEITIS FIBROSA; OSTEOFIBROMA; OSSIFYING FIBROMA

"Osteitis fibrosa" literally refers to the process in which there is fibrous proliferation in the marrow spaces and new bone formation with resorption of old bone. In the group of tumors classified variously under osteitis fibrosa and as ossifying fibroma and osteofibroma, we see the microscopic picture of new bone formation; that is, bone islands or irregular trabeculae, with active osteoblasts and cellular connective tissue, and resorption of old bone, which represent a defensive reaction on the part of bone to pathologic invasion by infection, tumor formation or some other factor as yet undetermined; a benign process which, however, shows a tendency to recur after surgical treatment in some cases.

In the early stages of this condition, there may be and probably is benign giant-cell activity. This condition is seen in the long bones of the body as well as the jaws, occurring as a solitary lesion; that is, confined to one bone. Either jaw may be affected, edentulous as well as dentulous, and the age varies.

These cases usually present a hard swelling of varying size depending on the time interval between the onset of the swelling and the period at which the patient seeks treatment. The overlying mucous membrane is usually normal in color unless traumatized by occlusion, and is smooth in contour and not thickened.

Fig. 3.—Photomicrograph of bone cyst showing wall of connective tissue (fibroblasts) with new bone formation about periphery.

The appearance frequently is that of a bulging outward of a portion of the bone.

The lesion is painless and benign, and the rate of growth slow. It occurs as a solitary lesion with normal serum calcium and phosphorus.

In the roentgenogram, a bulbous enlargement of bone not so dense as the normal may be seen and central areas of rarefaction usually appear in the bone. If the peripheral bone is of compact structure, as in cortical bone, the outline will give the appearance of increased density. Still other cases will show a well-defined area of rarefaction or more than one rarefied area in the bone, due to resorption of the central cancellous bone. These tumors are of subperiosteal origin probably and may be activated by some irritation either from trauma or through infection.

Evidence is against a bacterial causative condition, however, both in the long bones and in the jaws, for the reason that leukocytic infiltration is absent in the microscopic sections.[1] Leukocytes may be found, however, if there has been hemorrhage into the area or in case of fracture. Furedi[2] has reported bacterial foci in the bone marrow in four of seven cases showing compact bone, rather than those cases

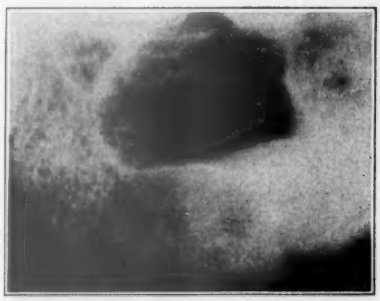

Fig. 4.—Localized osteitis fibrosa in edentulous maxilla of man, aged 66. The central areas of rarefaction are due to resorption of cancellous bone.

showing rarefaction. The teeth were present in three of the four cases with normal pulp test response and negative x-ray findings on the apical areas or pericemental membrane. One case showed a granuloma microscopically. The pulps were normal in the other cases studied microscopically.

The pathologic process is definitely of a defensive or reparative nature and may be influenced by the conditions controlling calcium metabolism, but to date no specific knowledge is available as to such a relationship in these solitary lesions of osteitis fibrosa.

### OSTEOMA

Osteomas may consist of cellular vascularized connective tissue proliferating between irregular bony trabeculae, but as a rule they contain a predominance of differentiated, adult laminated bone. The eburnated or hard osteoma is composed of dense bone with haversian spaces and little or no cellular connective tissue. The microscopic picture is one of bone structure without marked osteoblastic or osteoclastic activity.

Location of these tumors may be in the center of the bone as well as on the surface. The majority are to be found projecting from the surface of the bone.

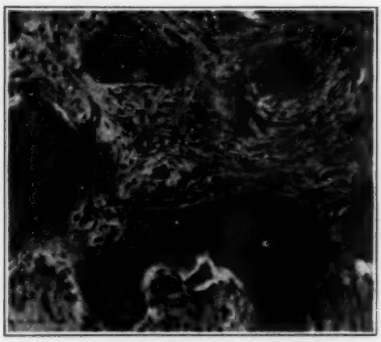

Fig. 5.—Photomicrograph of lesion shown in Figure 4; proliferation of fibrous tissue in marrow spaces with irregular areas of trabeculation of new bone, bone islands and osteoclastic resorption of older bone. Rows of active osteoblasts are forming new bone.

Fig. 6.—Localized osteitis fibrosa in molar region of maxilla in a man, aged 23. There is increased density of this mass, which is a hard, bulbous swelling, smooth in contour, spherical and covered with smooth, normal mucous membrane.

In general, osteomas are smaller than the lesions of osteitis fibrosa or osteofibroma and the patient is older.

The origin of these tumors, like that of the osteofibroma, is subperiosteal. The base attachment to the bone, in a surface tumor, may be broad or pedunculated.

### GENERALIZED OSTEITIS FIBROSA OR OSTEITIS FIBROSA CYSTICA (HYPERPARATHYROIDISM)

The term generalized osteitis fibrosa or osteitis fibrosa cystica is applied to that condition which manifests itself by simultaneous multiple bone lesions throughout various bones of the body, chiefly the spine, pelvis and long bones and including the jaws. It has been shown definitely that this condition is due to either an adenoma (glandular tumor) or a hyperplasia of the parathyroid glands.

Such a parathyroid gland involvement results in excessive calcium excretion with consequent loss of lime salts in the bones. Blood chemistry studies reveal an increase in serum calcium of upward of 10 mg. per hundred cubic centimeters of blood serum and a decrease in phosphorus to below 3.5 mg. per hundred cubic centimeters; which are near the normal. (Calcium is 9 to 11 mg. normal, phosphorus 2.5 to 3.5 mg. normal.)

In this disease, serum calcium ranges from 12 to 20 mg. per hundred cubic centimeters and serum phosphorus from 1 to 2 mg. per hundred cubic centimeters.

Normal calcium excretion is 0.3 gm. in twenty-four hours. In this disease, the calcium excreted is from 6 to 8 times the normal.

The presence of an excess of free cal-

cium results in the formation of calcareous deposits or stones in the kidneys, leading in many instances to obstruction, infection and failure of function, which may be bilateral or unilateral.

The bones become brittle and fracture easily. Frequently, such a fracture of a bone is the first indication of disease and the cause of the patient's search for treatment.

In other cases, a swelling over a bone is the first symptom and the x-rays will reveal an area of bone rarefaction. The long bones and pelvis show most frequent involvement, but the jaws may be involved early in certain cases. Pain or tenderness may be evident to the patient as bone changes take place.

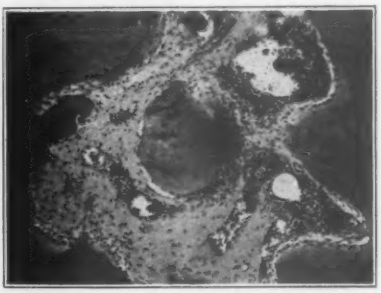

Fig. 7.—Photomicrograph of Figure 6, showing proliferation of fibrous tissue, new bone formation around old bone and bone islands. Leukocytic infiltration is due to hemorrhage.

The age incidence varies from youth to late adult life. Both sexes may be affected.

Trauma does not play a part in this disease, although a bone fracture may follow a slight injury or muscle twist as the initial symptom, particularly as it concerns the long bones. As previously pointed out, the disease is definitely due to tumor of the parathyroid glands (four in number normally).

More or less logically, as one would expect, the loss of calcium in the bones results in a replacement of the lost calcium by fibrous tissue, which does not completely calcify as long as the causative factor remains.

Consequently, the microscopic picture is one of fibrous tissue, benign giant-cells or osteoclasts destroying or ingesting bone, new osteoid structure with demonstrable active osteoblasts and cyst formation. With the exception of the cyst formation, which is not present always, the microscopic process is much like that seen in the entity of solitary osteitis fibrosa.

### BENIGN GIANT-CELL TUMOR

Although benign giant-cell activity is found in early bone cysts, in early localized osteitis fibrosa, and as a part of generalized osteitis fibrosa, the solitary benign giant-cell tumor is clearly a lesion to be considered as an entity in many instances.

Fig. 8.—Extensive localized osteitis fibrosa in mandible of woman, aged 37. The condition was of twenty years' duration.

A bone cyst may be an arrested benign giant-cell tumor. An arrested lesion of generalized osteitis fibrosa in the bone may appear as a bone cyst. Localized osteitis fibrosa bears less relationship except in its early stages, when there is more benign giant-cell activity.

A typical benign giant-cell tumor may appear in the jaw with every characteristic of a solitary benign giant-cell tumor, only to be found a part of a generalized osteitis fibrosa (cystica) as revealed by roentgenograms of the other bones of the skeleton, notably the long bones, pelvis and spine, together with the blood chem-

istry studies revealing a hypercalcemia with elevated serum calcium and lowered serum phosphorus content.

The benign giant-cell tumor as a typical lesion shows no alteration in the calcium or phosphorus levels in the blood serum and appears as a solitary bone lesion, important points of differentiation from the lesions of generalized osteitis fibrosa.

It may be well to emphasize that this condition, although known as a benign giant-cell tumor, is not neoplastic; rather, it is a reaction to inflammatory stimulus.

That it is not a true neoplasm is proved by the character of the foreign body giant cells, which are not true tumor giant cells, and its tendency to become arrested, at times forming a bone cyst; also by the fact that there is organization of certain hemorrhagic areas and the formation of fibrous tissue.

The benign giant-cell tumor as such apparently is related in general to cartilaginous ossification, especially in the long bones, and occurs in the epiphyseal ends of the long bones where adult bone is formed by precartilaginous ossification.

In the jaws, these tumors are found in areas in which or near which there are cartilaginous remnants, as in the symphysis and posterior body of the mandible, and the region of the inferior turbinate in the upper jaw. The upper jaw is a membranous bone, but the mandible is formed partly by intracartilaginous ossification, and partly by direct fibroblastic action.

There are other cases of solitary benign giant-cell tumor which cannot be attributed directly to precartilaginous ossification or associated with such a process. In other cases, there may be an endocrine factor involved (parathormone) which, to date, has not been demonstrated in any conclusive number of cases.[3] We know also that the foreign body giant-cell, which is the predominant cell in this tumor, is derived partly from the endothelial leukocyte and the primitive mesenchymal cell, which differentiate into the foreign body giant-cell and consequently may be found in the connective tissues of the body throughout adult life. Thus, it may be recognized that the benign giant-cell tumor may be independent of cartilaginous areas.

Benign giant-cell tumors may result from trauma or some inflammatory process and may progress rather rapidly, developing in a period of a few months to fifteen months from the time of injury. The symptoms of pain and swelling are more severe and the lesion tends to be progressive in the sense that it will extend

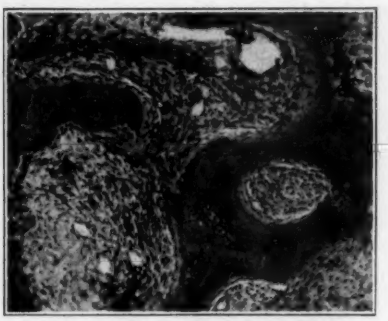

Fig. 9.—Photomicrograph of lesion shown in Figure 8; typical microscopic appearance of localized osteitis fibrosa, new bone formation and fibroblastic proliferation in marrow spaces.

Fig. 10.—Central osteoma in maxilla in the molar region in a woman, aged 41.

through the cortex of the bone to the neighboring soft tissues. The lesions then show a tendency to recur. For this reason, an intact cortical shell of bone and adequate blood supply are important factors in the healing and arrest of these tumors.

In the roentgenogram, the typical case may show trabeculation, and if seen early may show a subcortical location, which later will become central. Advanced cases may present an area of rarefaction due to bone destruction which differs in no respect from other central rarefied lesions of the jaws. In view of the greater resistance of cortical bone to the progress of the lesion, the cancellous bone in the central portion will be destroyed more rapidly and over a larger area.

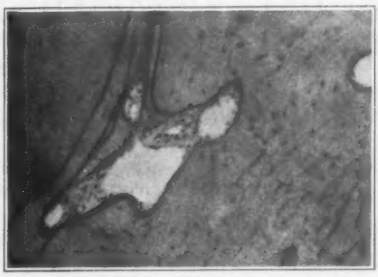

Fig. 11.—Photomicrograph of lesion in Figure 10, showing differentiated adult laminated bone with haversian spaces.

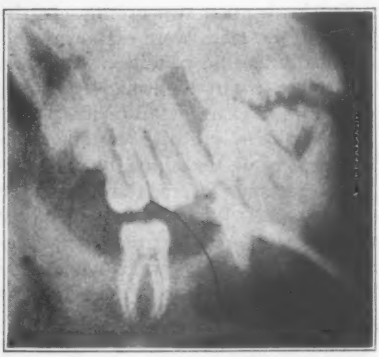

Fig. 12.—Benign giant-cell tumor in mandible extending from molar region to lateral incisor area, in a boy, aged 18.

The age factor is variable. Forty per cent of these lesions occur at about thirty to forty years of age in the long bones, but they may be found in the jaws at any age from one to seventy years. They are benign and do not metastasize.

Grossly, the benign giant-cell tumor tissue is reddish or reddish brown owing to hemorrhage, although this color is not constant. It is very hemorrhagic when disturbed and is brittle or friable. It may or may not be encapsulated.

The microscopic appearance of this tumor is one of abundant foreign body giant-cells to the low power field (30), each foreign body giant cell containing upward of fifteen or more nuclei per cell.

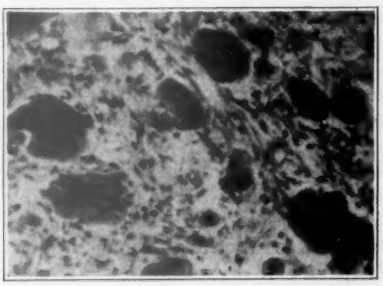

Fig. 13.—Photomicrograph of lesion in Figure 12, showing characteristic microscopic appearance of benign giant-cell tumor; numerous multinucleated foreign body giant-cells in a stroma of spindle and round fibroblasts with areas of hemorrhage (hemosiderin), and bone spicules.

It should be remembered that the foreign body giant-cell is not a true tumor giant-cell as found in malignant tumors. The stroma consists of fibrous tissue in strands running through the tumor, as well as spindle-shaped and round connective tissue cells. Areas of hemorrhage or red-blood cells with hemosiderin are frequent and bone spicules are to be found as a rule. This combination of foreign body giant-cells in large numbers, blood pigment and bone spicules is diagnostic mi-

croscopically of the benign giant-cell tumor.

BIBLIOGRAPHY

1. Parker, F. C.: Personal communication to the author, 1935.
2. Furedi, Anna: Study of Osteofibromas of Maxilla. *D. Cosmos*, 77:1004-1005, October 1935.
3. Geschickter, C. F., and Copeland, M. M.: Tumors of Bone; revised, New York: American Journal of Cancer, 1936, pp. 324-326.

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# RECENT STUDIES RELATING TO PERIAPICAL INFECTION, INCLUDING DATA OBTAINED FROM HUMAN NECROPSY STUDIES*

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THE general acceptance of the hypothesis of focal infection was followed by bacteriologic studies of tooth apices. These dealt almost solely with the pulpless tooth and teeth with apical granulomata. The emphasis given to these specific groups was probably due to the ease with which pathologic changes about their apices could be determined by roentgenologic examination. Studies of teeth with no periapical radiolucent changes have been few and have been inconclusive as to the absence or the frequency of organisms in the periapical region.

A historical review of periapical bacteriologic studies was given in an earlier report.[1] The results derived from previous studies can be summarized briefly according to the type of teeth cultured and the manner in which material was obtained for bacteriologic examination. They may be grouped conveniently as: (1) those in which extracted teeth were examined without controls [2, 28 to 48] (2) those in which extracted teeth were examined with controls, [3, 49 to 54] and (3) those in which cultures were obtained in the clinic from the teeth *in situ*.

The majority of the studies are included in the first two groups. In these divisions, the teeth were extracted under supposedly aseptic conditions and apical cultures or smears then made. The type of lesion, the exact detail of the methods used and the cultural results varied. Streptococci of the alpha type, *Streptococcus viridans*, were those most frequently isolated. Since control cultures were not reported from non-carious teeth, the question arises whether the apical findings are due to the actual presence of organisms in the periapical region or to contamination from mouth flora during removal.

Other investigators have attempted to control the periapical bacteriologic findings by culture of non-carious teeth or those without periapical radiolucent areas. The results obtained by these workers from the teeth with periapical radiolucent lesions were similar to those previously reported, but widely variant findings were obtained on bacteriologic

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examination of the control or non-carious teeth. This suggests the need for further investigation with better controlled technical methods.

A few workers secured clinical periapical cultures from teeth *in situ*. The material for cultures was obtained after the root tip and periapical area had been exposed by elevating the buccal mucosa and removing the cortical bone over the apical area, the method usually used in root amputation. Garvin[4] made a few cultures by this method and Berwick[5] examined seventy-one radiolucent periapical areas and also regions appearing normal in the roentgenogram. Lucas,[6] Coriell[7] and Grossman[8, 54] cultured teeth *in situ*, but they were unable to obtain adequate numbers of normal or non-carious teeth for controls. None of these workers were able to correlate the bacteriologic and roentgenologic examinations in every case.

Appleton[9] emphasized the external approach method of culturing as affording the most satisfactory technic for periapical bacteriologic culture. Both Bulleid[10] and Bertwistle,[11] who used extracted teeth for study, pointed out that by employing this method, all types of periapical lesions, the more acute ones, granulomata and cysts, could be examined satisfactorily. Owing to technical difficulties, clinical studies utilizing the external approach method were limited to the examination of single-rooted teeth with apical lesions.

With the establishment by Burn[12] of the value of postmortem bacteriology, dental tissues obtained at necropsy were considered as a possible source of material for well-controlled studies of tooth apices. He showed that the bacteriologic findings from human tissues cultured within a few hours after death do not differ significantly from those obtained from twenty-four to seventy-two hours later provided the bodies have been placed at 10° C. shortly after death. Burn and Harvey[13] also showed that no significant differences existed between clinical cultures of the blood taken shortly before death and those taken at necropsy.

The present investigation consists of periapical bacteriologic, roentgenologic and histologic studies of human necropsy material, and for most of the cases, hospital records include the findings derived

TABLE 1.—FREQUENCY OF ORGANISMS ISOLATED FROM THE TWO HUNDRED SIX PERIAPICAL AREAS

| | Pure and Mixed Cultures | | Pure Cultures | |
|---|---|---|---|---|
| | No. | Per Cent | No. | Per Cent |
| Streptococcus viridans | 127 | 61.2 | 58 | 28.0 |
| Streptococcus hemolyticus | 21 | 10.2 | 4 | 2.0 |
| Non-hemolytic streptococcus | 35 | 17.0 | 3 | 1.4 |
| Staphylococcus aureus | 66 | 32.0 | 31 | 15.0 |
| Staphylococcus albus | 4 | 2.0 | 2 | 0.97 |
| Bacillus coli | 9 | 4.4 | 8 | 3.9 |
| Pneumococcus | 6 | 2.9 | 4 | 2.0 |
| Gram-negative coccus | 9 | 4.4 | | |
| Gram-positive rod (unidentified) | 5 | 2.4 | 3 | 1.4 |
| Pseudomonas pyocyanea | 4 | 2.0 | 4 | 2.0 |
| Gram-negative rod (unidentified) | 4 | 2.0 | 1 | 0.49 |
| Bacillus typhosus | 2 | 0.97 | 2 | 0.97 |
| Diphtheroids | 1 | 0.49 | 1 | 0.49 |
| Haemophilus influenzae | 1 | 0.49 | 1 | 0.49 |
| Gram-positive coccus (unidentified) | 1 | 0.49 | | |
| Micrococcus tetragenous | 1 | 0.49 | 1 | 0.49 |

from physical and laboratory examinations. Bacteriologic studies of the blood stream and viscera made at necropsy were also available for comparison with the periapical cultures and the clinical bacteriologic findings. There were no restrictions as to the type or number of teeth which could be examined, and subsequent serial histologic sections of the teeth and of lesions cultured enabled a correlation of the anatomic or pathologic changes with the bacteriologic and roentgenologic findings. In addition to a thorough clinical study of the cases, the general pathologic findings were available for comparison with the changes observed in the dental structures. All the cultures were made in the bacteriologic laboratory with the teeth *in situ* and therefore a sepsis seldom attainable in clinical studies was maintained routinely.

Cases were selected for study when the patient's illness consisted of a constitutional disease with oral manifestations or when dental or other foci of infection were presumed to be the causes of the pathologic alterations in remote parts of the body. In addition, numerous accidental deaths were also included in the series.

A complete intra-oral examination, including dental films of all the teeth, was made prior to the removal of the specimen. Adequate tissue was always obtained to avoid any disturbance of the periapical region so that maxillary specimens usually included portions of the maxillary sinus and those from the mandible portions of the mandibular canal. Repeat roentgenograms were taken after the specimen was removed. In the bacteriologic laboratory, cultures were made by a modification of the root amputation method. The detailed technic of culturing and the steps in the bacteriologic procedures have been reported previously.[1]

Data were compiled from 445 teeth obtained from 138 necropsies. The twenty-six teeth with periapical cultures similar to the blood stream findings were omitted from the accompanying tabulations.

Fig. 1.—Teeth with no periapical roentgenological change.

The majority of the patients included in this study were between the ages of 20 and 50. A representative group also was obtained for the earlier and for the later years.

Cultures from 419 periapical areas were analyzed, of which 206, or 49 per cent, contained organisms. An average of four periapical areas were cultured in each case in addition to examinations of the alveolar marrow substance at the site of previous tooth extraction. The fre-

quency of the various bacteria isolated from the 206 periapical areas is given in Table 1.

For clarification in the presentation of the bacteriologic findings, the teeth were placed in one of the following groups on the basis of the periapical roentgenologic findings:

1. XN: Two hundred eighty-three showed no periapical roentgenologic change. Teeth from this group are shown in Figure 1.

2. XPS: Sixty-five showed slight periapical roentgenologic change. This group included teeth with a "slight diffuse radiolucent area about the apex" or a "slight thickening of the peridental membrane." Some of the lesions included in this group are shown in Figure 2.

3. XPL: Seventy-one showed marked periapical roentgenologic changes. This group included "dental granulomas," "large diffuse radiolucent areas" and all other periapical changes. Some of the lesions included in this group are shown in Figure 3.

The percentage of positive cultures obtained in the different roentgenologic groups is given in Table 3.

Thirty per cent positive cultures from teeth with no periapical roentgenologic change are doubtless due to the actual presence of bacteria in the periapical tissue as the teeth were cultured *in situ* by the external approach method. The frequency of pure and mixed cultures in the different roentgenologic groups is shown in Table 4.

There was a definite decrease in the percentage of pure cultures and an increase in the percentage of mixed cultures with the development and increase in size of the periapical radiolucent area.

The teeth were also grouped according to their gross findings in one of the following divisions.

1. Non-carious: Teeth with no clinical evidence of caries, 92.

2. Carious: Teeth in which caries was present with no evidence of pulp exposure, 144.

3. Restorations: Teeth in which restorations had been made, 115.

4. Exposures: Teeth in which the

TABLE 2.—FREQUENCY OF ORGANISMS ISOLATED IN MIXED CULTURE

| Two Orgamisns | No. |
|---|---|
| Streptococcus viridans and | |
| (a) Non-hemolytic streptococcus | 27 |
| (b) Streptococcus hemolyticus | 7 |
| (c) Staphylococcus aureus | 11 |
| (d) Staphylococcus aureus (hemolytic) | 7 |
| (e) Staphylococcus albus | 1 |
| (f) Gram-negative coccus | 6 |
| (g) Gram-negative rod | 2 |
| (h) Gram-positive coccus | 1 |
| Non-hemolytic streptococcus and | |
| (a) Streptococcus hemolyticus | 1 |
| (b) Staphylococcus albus | 1 |
| Staphylococcus aureus and | |
| (a) Streptococcus hemolyticus | 5 |
| (b) Gram-positive rod | 2 |
| (c) Bacillus coli | 2 |
| Staphylococcus aureus (hemolytic) and | |
| (a) Staphylococcus albus | 3 |
| (b) Staphylococcus aureus | 2 |

| Three Organisms | No. |
|---|---|
| Streptococcus viridans with Streptococcus hemolyticus and gram-negative coccus | 2 |
| Staphylococcus aureus and gram-negative coccus | 2 |
| Non-hemolytic streptococcus and gram-negative rod | 1 |
| Non-hemolytic streptococcus and Staphylococcus aureus | 1 |

pulp chambers were in communication with the oral cavity, 50.

5. Pulpless: Teeth in which a radiopaque material was observed in the root canals on roentgenologic examination, 28.

The percentage of positive periapical cultures obtained from the different gross groupings is summarized in Table 5.

Positive periapical cultures were obtained in about the same frequency from non-carious as from carious teeth. Histologic studies revealed only an occasional microscopic lesion in the coronal portion of the non-carious teeth. The percentage frequency of the more common organisms cultured from each of the gross groupings is given in Table 6.

Histologic examination of the periapical region revealed that 96 per cent of the cultures were made from the apical region of the tooth. Negative cultures were obtained in all instances where the apex was not reached. Results of cultures made deliberately from the alveolar bone marrow were negative in thirty-four of thirty-five examinations. The positive culture was of an organism similar to that recovered from the blood stream at postmortem. While this group of marrow cultures is small, it emphasizes the significance of the higher percentage of positive cultures obtained from the periapical region.

A comparison was also made between

Fig. 2.—Teeth with slight periapical roentgenological change.

Except for the high incidence of *Streptococcus viridans,* no particular bacterial flora was observed in any of the gross groupings. The higher percentage of incidence of this organism observed in the carious, filled and embedded root group, which was present as a constituent of a mixed culture, suggests that, in these groups, a direct bacterial invasion has occurred from the oral cavity through the dentin and root canal of the tooth itself. The ratio between the percentage of pure and mixed cultures of *Streptococcus viridans* in the different clinical groups is given in Table 6.

the frequency with which the organisms are found in the viscera, that is the liver, kidneys and spleen, and in the periapical region of the same case. *Streptococcus viridans* constituted only 8.3 per cent of the organisms of all the positive visceral cultures, but 62 per cent of those of the periapical cultures. There is a definite and significant increase in the frequency with which *Streptococcus viridans* is found in the periapical region as compared to the alveolar marrow substance or the abdominal viscera.

A preliminary correlation of the periapical bacteriologic and roentgenologic

findings with the apical histology has been made in Table 8.

The relation between the roentgenologic and the histologic findings was closer than that of the bacteriologic and histologic findings. This is readily understood when it is recognized that the roentgenologic lesion is dependent on a structural change or abnormality. The degree of gingival infection or the amount of alveolar resorption observed histologically could not be correlated with the bacteriologic findings of the periapical region. (Teeth with marked pyorrheic involvement and those readily movable in the alveolar process were not considered suitable for culturing, regardless of the clinical condition of the crown.)

Table 3.—Positive Cultures Obtained From Different Roentgenologic Groups

| Group | No. | Per Cent |
|---|---|---|
| XN | 283 | 30.6 |
| XPS | 65 | 76.0 |
| XPL | 71 | 60.8 |

Table 4.—Pure and Mixed Cultures in the Different Roentgenologic Groups

| Group | No. of Teeth | Pure | Two Per Cent | Three |
|---|---|---|---|---|
| XN | 283 | 65 | 34 | 1 |
| XPS | 65 | 57 | 42 | 1 |
| XPL | 71 | 52 | 44 | 4 |

In summarizing the results of these postmorten studies, we are aware of the fact that periapical bacteriologic studies carried out in different groups of individuals, such as those from hospital ward service or those from private practice, might give different results. The postmortem and clinical findings for the periapically roentgenologically positive teeth are mutually confirmatory, but 30 per cent positive cultures were obtained from the periapically roentgenologically negative teeth. As all of these cultures were made with the teeth *in situ*, it is believed that they represent the actual presence of bacteria in this region. Streptococci were recovered from 89 per cent of the teeth with positive periapical cultures; and 62 per cent of all the cultures were of *Streptococcus viridans*. This organism was the predominating one recovered from the different roentgenologic and gross groupings, but in no instance was it cultured from the alveolar marrow substance. A higher percentage of pure cultures was obtained from the periapically roentgenologically negative teeth than from those with apical roentgenologic changes and the frequency of mixed cultures increased with the development and increase in size of the periapical roentgenologic lesion. A more complete analysis of the histologic, roentgenologic and bacteriologic findings is now in progress.

Table 5.—Positive Cultures Obtained from Different Clinical Groups

| Group | No. of Teeth | Positive Per Cent |
|---|---|---|
| Non-carious | 92 | 43 |
| Carious | 144 | 38 |
| Restorations | 115 | 50 |
| Exposures | 50 | 68 |
| Pulpless | 28 | 72 |

While the rôle that periapical infection may play in focal infection is dependent on the presence of bacteria or bacterial products in the periapical region, of equal importance are the factors in the dissemination of bacteria from this region or the localization of organisms in this area from other parts of the body. The actual significance of periapical infection cannot be determined properly until we have as much knowledge concerning these factors as we have concerning the frequency of occurrence and type of organisms. The capacity of *Streptococcus viridans* to change its

pathogenicity, or its disease-producing ability, is uncertain.

Proof that organisms are disseminated from the periapical region has been substantiated largely on the basis of clinical experience. The onset of septicemia, acute hemorrhagic nephritis or sub-acute bacterial endocarditis following an acute alveolar abscess or the removal of an infected tooth has been accepted as clinical evidence of dissemination. The relation between dental foci of infection and the eye is perhaps the most definite example and the response to treatment most satisfactory. Less conclusive evidence of the possible rôle of periapical infection is found in some of the more chronic diseases, such as diabetes and arthritis. The possibility of paradental foci of infection playing a major rôle in these conditions has not been given sufficient emphasis.

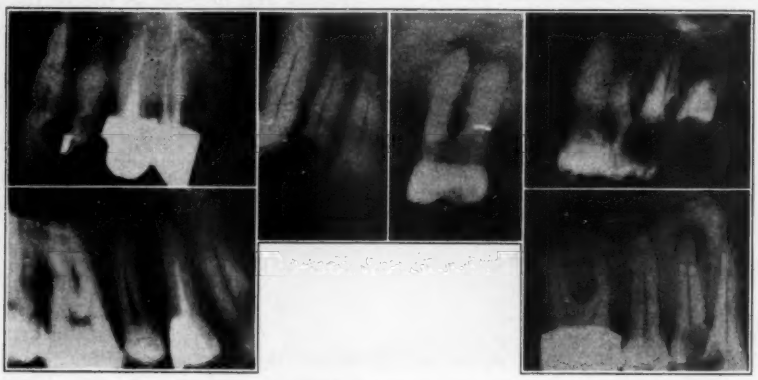

Fig. 3.—Teeth with marked periapical roentgenological change.

Although the dissemination of bacteria through the systemic circulation following the simple extraction of a tooth is commonly regarded as unusual, Okell and Elliot,[14] two English workers, have recently demonstrated bacteremia in 76 per cent of their cases. Hospital patients were used for the study and cultures were taken prior to and after the removal of the teeth under nitrous oxide anesthesia. The positive cultures could be correlated roughly with the degree of mouth infection. No mention was made of the preparation of the gingival tissues prior to the extraction. *Streptococcus viridans* was recovered most frequently.

Round *et al.*[15] have demonstrated in persons with pyorrhea that the trauma incident to mastication was sufficient to produce a demonstrable bacteremia. This study emphasizes particularly the importance of the consideration of paradental disease as a focus.

In confirmation of the work of Round *et al.*, we found that blood cultures obtained ten minutes after the removal of teeth under local anesthesia are frequently positive. In order to establish the source of the bacteria demonstrated in the blood stream, a non-pathogenic bacterium which could be readily identified *(B. prodigiosus)* was painted around the gingiva just prior to the removal of the tooth. The trauma incident to extraction forced a sufficient number of bacteria into the blood stream to be demonstrable in the blood cultures made ten minutes later. Attempts were made to sterilize the gingival crevice with one-half strength tincture of iodine. Except in rare instances, this procedure only reduced the staphylococcal flora and left almost pure

cultures of streptococci in the gingival crevice. This fact may have some bearing on the results obtained from periapical cultures of extracted teeth. Vigorous massage of pyorrheic gums for five minutes introduced bacteria into the blood stream in demonstrable numbers.

While bacteremia produced traumatically is more easily demonstrated on human subjects, recent animal experiments suggest that subtle changes in the host itself may be of equal importance in disseminating organisms from the periapical region or dental periosteum. Weisberger[16] showed that, in rabbits, the hypersensitive state prolonged the duration of positive blood and visceral cultures following an experimental bacteremia. His more recent studies[17] on the effect of sensitization of the host have shown that organisms present in the periapical region can be disseminated at will by "shocking" an animal (rabbit) previously sensitized with horse serum. A strain of *Streptococcus viridans* isolated from a diseased tooth was used in these experiments, and endocarditis was produced in the rabbit. It is possible, therefore, that the consideration of certain allergic states in the individual might be necessary in determining the significance of periapical infection.

The effect of periapical infection on the organism as a whole has been studied from both the clinical and the laboratory approach. Frankel[18] analyzed the dental and systemic findings on 19,000 persons insured by the Metropolitan Life Insurance Company and found no correlation between any systemic disturbance and the extent of dental restorations. Appleton's[19] statistical study showed no increase in the amount of systemic disease in those with the greatest periapical infection as judged by clinical and roentgenologic examination. Arnett and Ennis'[20] study of dental roentgenograms in connection with the past history and physical examination of 800 college students demonstrated no relation between periapical infection and any particular disease entity. These authors assumed that all periapical radiolucent areas were infected. Ziskin's[21] study dealing with quantitative roentgen-ray changes associated with systemic findings led to no definite conclusion relative to the type or size of the periapical radiolucent area and systemic manifestations. His observations failed to substantiate Weston A. Price's[22] theories concerning the size and type of periapical radiolucent area as indicating individual susceptibility or resistance to disease. (Pollia[23] has summarized clearly and accurately the newer concepts of focal infection.)

Evidence from laboratory studies of the rôle of periapical infection in the causation of systemic disease is even less convincing. These experimental procedures included destruction and removal of the pulp or the injection of large quantities of organisms directly into this

TABLE 6.—FREQUENCY OF MORE COMMON ORGANISMS ISOLATED FROM DIFFERENT GROSS GROUPS OF TEETH

| Organism | Non-carious | | Carious | | Restorations | | Exposures | | Pulpless | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Per Cent | No. | Per Cent | No. | Per Cent | No. | Per Cent | No. | Per Cent |
| | 40 | | 54 | | 58 | | 20 | | 28 | |
| Streptococcus viridans | | 42 | | 61 | | 57 | | 82 | | 30 |
| Streptococcus hemolyticus | | 10 | | 6 | | 14 | | 6 | | 15 |
| Non-hemolytic streptococcus | | 10 | | 26 | | 12 | | 6 | | 30 |
| Staphylococcus aureus | | 34 | | 31 | | 34 | | 41 | | 25 |
| Bacillus coli | | 0 | | 6 | | 5 | | 0 | | 15 |

tissue and those in which it was attempted to simulate conditions existing in man when a gradual exposure of the dental pulp occurs and contact with the oral flora is allowed. Dogs or other animals whose dental tissues (apical foramen) are not comparable to man's have been employed frequently. The *Macacus rhesus* monkey used by Miller[24] and Genvert[25] revealed no systemic response as evidenced by frequent blood counts, sedimentation tests and daily temperature readings, following or concurrent with the development of the periapical lesion as determined by the roentgenogram. On rare occasions, a positive blood culture was obtained, but its interpretation was difficult in the light of known transient bacteremia in the monkey and the

Table 7.—Ratio Between Percentage of Mixed and of Pure Cultures of Streptococcus Viridans in the Different Gross Groups

| | |
|---|---|
| Non-carious | 1.2 |
| Carious | 2.5 |
| Restorations | 2.3 |
| Exposure | 2.2 |
| Pulpless | 1.5 |

lack of systemic response in the animal at the time the culture was positive. When periapical cultures were obtained by a method similar to that used in man, bacteria were isolated from some of the periapically roentgenologically negative teeth and many of the teeth with periapical radiolucent areas contained no organisms which could be demonstrated by smears or on culture. The fact that animals may possess hereditary tendencies and susceptibilities which are in no way comparable to those of the human organism must not be disregarded.

Findings confirming the localization of bacteria in the periapical area from the blood stream are more convincing. Beretta[26] and others have shown that after an experimental bacteremia in guinea-pigs and dogs, the test organisms can be demonstrated in the dental pulp and periapical tissues, after the blood stream and viscera have become negative. Inconclusive results were obtained in the attempts of Genvert and Miller[24, 25] to confirm this finding in monkeys.

In the study of the human necropsy material, an organism was demonstrated occasionally in the blood stream clinically, which, because of its unusual growth characteristics or structure, could be identified readily at necropsy. It is not known whether these particular organisms localized in the periapical region from foci elsewhere in the body or were disseminated from the periapical region. These cases illustrate, however, the importance of the blood stream as an agent in the general dissemination of organisms or their localization about the apices of human teeth.

In the first case, acute mitral endocarditis was found at necropsy, with pyelothrombophlebitis and thromboangiitis of the mesenteric vessels. The following clinical blood studies were obtained.

11-13-34: Undetermined gram-positive green-forming rod
11-19-34: *Streptococcus hemolyticus*
11-24-34: *Streptococcus viridans*
11-30-34: *Streptococcus viridans*
12-4-34: *Streptococcus viridans*
12-5-34: *Streptococcus viridans*
12-14-34: *Streptococcus viridans*

A comparison of the postmorten visceral and periapical cultures is given in Table 9.

In the second case, the clinical cultures ten days before death were positive for an unidentified gram-negative gas-producing rod. Postmortem blood and visceral cultures were all negative. The results shown in Table 10 were obtained in the periapical cultures.

An analysis of periapical cultures from cases in which positive blood cultures were obtained demonstrated clearly that the teeth with roentgenologic lesions

were more liable to harbor the organisms which were demonstrated in the heart's blood and that the frequency of positive cultures was greater in the teeth with large periapical areas. Whether the latter finding was due to sampling or to the presence of a more extensive vascular network in the large lesions which might favor bacterial localization is not known.

The importance of the peridental membrane as an avenue of invasion of bacteria to the periapical region is under investigation, using postmortem material. The study is not as yet concluded, but the evidence at hand does not reveal the importance of this structure as a pathway by which organisms reach the periapical region. The fact that organisms cannot be demonstrated in this tissue does not mean necessarily that they do not reach the apex by means of the dental periosteum.

The laboratory has contributed to the understanding of periapical infection. The use of postmortem material for laboratory investigations of the roentgenologic, histologic and bacteriologic findings on tooth apices has permitted better controlled methods than were possible in the earlier studies with extracted teeth. It has been demonstrated in man that organisms present in the blood stream may localize in the periapical region of teeth with apical disease. The part paradental infection may play as a focus of infection has been emphasized in recent studies, and the results suggest that it and periapical infection may be of equal importance.

The host has been receiving increasing consideration, but until we have as much knowledge of the conditions responsible for alterations in the resistance of the host and changes in the pathogenicity of

TABLE 8.—CORRELATION OF PERIAPICAL HISTOLOGIC, ROENTGENOLOGIC AND BACTERIOLOGIC FINDINGS

| | No. | Bacteriologically Positive Per Cent | Roentgenologically Positive Per Cent |
|---|---|---|---|
| Negative histologic, findings | 283 | 39 | 16 |
| Positive histologic, findings | 83 | 71 | 85 |

TABLE 9.—COMPARISON OF BLOOD, VISCERAL AND PERIAPICAL CULTURES

| Blood | Liver | Spleen | Kidney | Dental | X-Ray | Clinical |
|---|---|---|---|---|---|---|
| Streptococcus hemolyticus | Non-hemolytic streptococcus | Non-hemolytic streptococcus | Non-hemolytic streptococcus | Negative | Negative | Negative |
| Non-hemolytic streptococcus | Bacillus coli | Streptococcus viridans | Bacillus coli | Negative | Negative | Negative |
| | | Bacillus coli | | Negative | Negative | Negative |
| | | | Streptococcus viridans and gram-positive green-forming rod similar to previous blood culture | Negative | Negative Large diffuse radiolucent area | Negative Gold foil and silicate |

the organisms as we have of the type and frequency of bacteria found in the periapical region, the significance of periapical infection cannot be evaluated definitely. Weston A. Price's evaluation of the individual in terms of his ancestry is a step in this direction. It might afford a basis for preventive procedures which would otherwise not seem indicated. Price evaluates the resistance or susceptibility of the person by means of the size and type of periapical radiolucent changes. He postulates that a large periapical radiolucent area which is diffusely outlined indicates a high degree of resistance, a large lesion with condensing osteitis, a "broken susceptibility due to overload"; and a small bone change, "an inherited susceptibility to infection."

This lack of information is partly due to the concentration of thought and interest in the technical phases of the dental profession and also to the dearth of men with both medical and dental training who could analyze the existing data so that they would be useful for all concerned. With the passing of time, however, the dentist has assumed a more conservative attitude regarding teeth with roentgenologic changes about the apices. This conservatism has not been shared in the same degree by many physicians, probably because the dentist more frequently observes instances in which teeth are removed without improvement in the general symptoms.

A great contribution to the understanding of this problem would consist

TABLE 10.—COMPARISON OF BLOOD, VISCERAL AND PERIAPICAL CULTURES

| Blood Stream and Viscera | Tooth | X-Ray | Clinical |
|---|---|---|---|
| Negative | Negative | Negative | Negative |
| | Negative | Negative | Negative |
| | Negative | Negative | Amalgam |
| | Gram-negative gas-producing rod | Slight thickening in the dental periosteal space | Amalgam |
| | Micrococcus tetragenous | | |

These views, however, are not universally accepted.

Although complete understanding of a problem is the ultimate goal, it is also important that existing knowledge be used most effectively. In the beginning, the focal infection theory was received as enthusiastically by the medical and dental professions as any other new concept of disease, with the result that questionable teeth were removed to effect a cure or prevent the development of symptoms. If clinical improvement failed to occur, the tonsils, nasal sinuses, prostate, gallbladder and the other organs were examined. The efforts to eliminate foci of infection were worthy, but the failure to accumulate definite information relative to the results is unfortunate.

of the collection and analysis of a series of complete case histories. A similar approach was used in medicine to determine the effectiveness of different therapeutic procedures in the treatment of tuberculosis and cerebral tumors. This problem of periapical infection, however, must be a cooperative enterprise between the medical and the dental profession; for the dentist lacks the necessary records to make such a study and the physician is too apt to be concerned with the problems of his own profession to give serious consideration to such a survey.

Today, there is indeed a closer cooperation between the dentist and the physician, but a gap still exists because each lacks a sufficient knowledge and understanding of the other's profession. The

dentist, as a consultant, has an opinion as worthy of consideration by the physician as any other consultant in a medical specialty. Too often are the dentist's findings transmitted to the physician by the patient or by telephone. Only by actual contact between the members of these professions can a mutual understanding of the difficulties be obtained and existing knowledge concerning the problem of periapical foci of infection be understood.

Many physicians are still in the habit of referring patients to the dentist with instructions to remove certain teeth, but Miller,[27] a well-known medical clinician, states that "it is presumptuous for any physician arbitrarily to demand or order the removal of teeth, be they non-vital or otherwise, without consulting with a dentist well qualified and courageous enough to either agree or disagree." This quotation might aptly be paraphrased to include dentists who remove teeth on the physician's or patient's demand or request until it is certain that other foci of infection have been adequately searched for by the physician, and that the complaints for which the patient seeks relief outweigh the usefulness of the teeth and the financial outlay required to restore the lost structures.

BIBLIOGRAPHY

1. Burket, L. W.: Studies of Apices of Teeth. Correlation of Bacteriological, Roentgenological, and Gross Anatomical Findings in Human Necropsies. Part I. Review of the Literature. Methods Used. *Yale J. Biol. & Med.*, 9:271, January 1937; Part II. *Ibid.*, 9:287, March 1937.

2. Broderick, R. A.: An Investigation into Source of Infection of Necrotic Areas Found at Apices of Pulpless Teeth. *Brit. D. J.*, 46: 357, April 1, 1925.

3. Haden, R. L.: Radiographic Diagnosis of Periapical Dental Infection in Light of Bacteriologic Findings. *D. Cosmos*, 67:380, April 1925.

4. Garvin, M. H.: Foci of Infection in Relation to Nonvital Teeth. J.A.D.A., 6:195, March 1919.

5. Berwick, C. C.: The Bacteriology of Periodontal Tissues Radiographically Suggesting Infection. *J. Infect. Dis.*, 29:537, November 1921.

6. Lucas, C. D.: Periapical Infection. *D. Cosmos*, 71:555, June 1929.

7. Coriell, L. D.: Dental Trocar. *D. Cosmos*, 60:1154, December 1919.

8. Grossman, L. I.: Apicostomy: Method to Obtain Cultures from Periapical Tissues. *J. D. Res.*, 12:595, August 1932.

9. Appleton, J. L. T.: Clinical Dental Bacteriology. Review and Synthesis. *D. Cosmos*, 66:251, March 1924.

10. Bulleid, A.: Bacteriology of Apical Infection. *J. Brit. D. A.*, 49:855, August 3, 1928.

11. Bertwistle, A. P.: Rôle of Dead and Infected Teeth in Autogenous Infections. *Brit. M. J.*, 1:589, April 7, 1928.

12. Burn, C. G.: Experimental Studies of Postmortem Bacterial Invasion in Animals. *J. Infect. Dis.*, 54:388; Postmortem Bacteriology. 395, May-June 1934.

13. Burn, C. G., and Harvey, D. F.: Comparative Values of Clinical and Postmortem Blood Cultures. *J. Infect. Dis.*, 59:296-305, November-December 1936.

14. Okell, C. C., and Elliot, S. D.: Bacteriaemia and Oral Sepsis with Special Reference to Aetiology of Subacute Endocarditis. *Lancet*, 2:869, October 19, 1935.

15. Round, H.; Kirkpatrick, H. J. R., and Hails, C. G.: Further Investigations on Bacteriological Infections of Mouth. *Proc. Roy. Soc. Med.*, 29:1552, October 1936.

16. Weisberger, David: Influence of Hypersensitive State in Experimental Streptococcus Viridans Bacteremia. *Proc. Soc. Exper. Biol. & Med.*, 29:445, January 1932.

17. Weisberger, David: Relation of Hypersensitivity to Localization in and Dissemination of Streptococcus Viridans from Incisor Teeth of Rabbits. *Yale J. Biol. & Med.*, 9:417, May 1937.

18. Frankel, L. K.: Consideration of Evidences on Oral Sepsis in Relation to Systemic Disease. *D. Cosmos*, 66:35, January 1924.

19. Appleton, J. L. T., Jr.: Statistical Contribution to Problem of Focal Infection. *D. Cosmos*, 66:739, July 1924.

20. Arnett, J. H., and Ennis, L. M.: Dental Infection and Systemic Disease. *Am. J. M. Sc.*, 185:777, June 1933.

21. Ziskin, D. E.: Dental Infections: Comparative Systemic Effects of Quantitative Apical Changes. *J. D. Res.*, 11:285, April 1931.

22. Price, W. A.: Dental Infections, Oral and Systemic, Vol. 1. Cleveland: Penton Publishing Co., 1923.

23. Pollia, J. A.: Newer Concepts of Fo-

cal Infection. *J. D. Res.*, 11:83, February 1931.

24. MILLER, H. A.: Studies on the Pathogenesis and Systemic Response to Dental Foci of Infection Experimentally Produced in Monkeys. Unpublished data.

25. GENVERT, H. A.: Observations Concerning Experimental Production of Periapical Dental Infection in Monkeys. Unpublished data.

26. BERETTA, A.: Mikrobenlokalisation in der Zahnpulpa auf dem Wege der Blutbahn. *Centralbl. f. Bakteriol.*, 76:124, 1915.

27. MILLER, S. R.: Some Problems of Mutual Interest to Dentists and Physicians. *J. Am. Coll. Dentists*, 3:11, March-June 1936.

28. COLLINS, K. R., and LYNE, B. C.: Preliminary Report on Bacteria Found in Apical Tissues and Pulp of Extracted Teeth. J.A.D.A., 6:370, April 1919.

29. KAUFFER, H. J.: Discu. Rosenow, E. C.: *J. D. Res.*, 1:lxxiv, September 1919.

30. GOLDBERG, H. A.: Dental Infections: Systemic Manifestations and Bacteriologic Observations. *J.A.M.A.*, 89:356, July 30, 1927.

31. COTTON, H. A.: Relation of Oral Infection to Mental Diseases. *J. D. Res.*, 1:269, September 1919.

32. COOK, T. J.: Dental Granuloma. J.A.D.A., 14:2231, December 1927.

33. THOMA, K. H.: Infected Vital Dental Pulp; An Important Focus of Systemic Disease. *J. D. Res.*, 8:529, August 1928.

34. NICHOLS, ANNA C.: Virulence and Classification of Streptococci. J.A.D.A., 13: 1218, September 1926.

35. OTTOLENGUI, R.: Ricerche sulla Microbiologia della Carie Dentale. Flora Bacterica della Infezioni Periapicali. *Gior. di batteriol. e immunol.*, 3:114, February 1928.

36. ROHDENBURG, G. L., and FRANKEN, S. W. A.: Dental Granulomas. *J. A. M. A.*, 93: 191, July 20, 1929.

37. FELDMAN and HUTTNER: Cited by Appleton, J. L. T., Jr.: Bacterial Infection. Philadelphia: Lea & Febiger, 1933, p. 488.

38. BLUMENBURG, W., and ZULL, A.: Presence of Streptococci in Apical Granulomas. *Arch. f. Hyg.*, 109:297, February 1933.

39. GILMER, T. L., and MOODY, A. M.: Study of Bacteria of Alveolar Abscess and Infected Root Canal. *J. A. M. A.*, 63:2023, 1914.

40. HEAD, J., and ROSS, C.: Bacteriology of Apical Abscesses. *J. D. Res.*, 1:13, March 1919.

41. FLEMING, A., and MACCLEAN, I. H.: Occurrence of Influenza Bacilli in Mouths of Normal People. *Brit. J. Exper. Path.*, 11:127, April 1930.

42. ULRICH, H. L.: Blind Dental Abscess. *J. A. M. A.*, 65:1619, 1915.

43. HENRICI, A. T., and HARTZELL, T. B.: Dental Path. *Surg. Gynec. & Obst.*, 22:18, 19:6.

44. WEBER and PESCH: Cited by Appleton, J. L. T., Jr.: Bacterial Infection. Philadelphia: Lea & Febiger, 1933, p. 486.

45. MELA, B.: Infezione focale, storia; Ricerche sperimentali sull'infezione focale e in particolar modo sulla localizzazione elettiva degli streptococchi. *Stomatol.*, 32:702, August 1934.

46. MOODY, A. M.: Lesions in Rabbits Produced by Streptococci from Chronic Alveolar Abscesses. *J. Infect. Dis.*, 19:515, 1916.

47. FRASER, C. J.: Preliminary Report on Relation of Streptococcus Viridans to Periapical Infection. *J. Brit. D. A.*, 44:1350, December 1923.

48. ELLIS, R. C., and LUTEN, M.: Deciduous Teeth and Diseases of Childhood. J.A.D.A., 22:1117, July 1935.

49. AUSTIN, L. T., and COOK, T. J.: Bacteriologic Study of Normal Vital Teeth. J.A.D.A., 16:894, May 1929.

50. RICKERT, G. W.; LYONS, C. J., and HADLEY, FAITH P.: Studies on the Etiology of Root Canal Infections. J.A.D.A., 13:1203, September 1926.

51. RHOADS, P. S., and DICK, G. F.: Roentgenographically Negative Pulpless Teeth as Foci of Infection: Results of Quantitative Cultures. J.A.D.A., 19:1884, November 1932.

52. CRAMER, H. C., and REITH, A. F.: Quantitative Bacteriologic Study of Pulpless Teeth Correlated with Dental Roentgenograms. J.A.D.A., 19:976, June 1932.

53. ELLINGHAM, G. H.: Bacteriological Investigation into Some Filled Teeth. *J. Brit. D. A.*, 58:108, February 1, 1935.

54. GROSSMAN, L. I., and PRINZ, HERMANN: Bacteriologic Control of Periapical Tissue by Coriell Trocar Method: Anatomic Study. *D. Cosmos*, 72:220, March 1931.

# THE PORCELAIN INLAY—INDIRECT METHOD

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WITH the introduction of the silicate cements several decades ago, the use of porcelain as a filling material was almost discarded. Today, we find it once again in general favor. Prior to the time the silicate cements became popular, the porcelain inlay was constructed by the direct method; today, the indirect method is more generally used. The reason for this change in the constructional method is not at all obscure. In the early days, the operator built and fired his own inlay, whereas, today, the operative and laboratory procedures are usually executed by different persons.

Regardless of which method is used, the advantages of one should not be overlooked when the other is being applied. The direct method has one outstanding advantage: In it, the matrix is adapted directly to the cavity walls and margins. Not until this same accuracy can be developed in the indirect method can it be said to be the better one.

In order to secure a similar marginal accuracy in the indirect method, it is necessary that the impression and model materials reproduce with absolute likeness and show no volume change or distortion during the process of manipulation. When this is accomplished, the added advantages of the indirect method are numerous.

Assuming that the impression and model give an exact reproduction of the cavity, we find that laboratory procedure is simplified and can be carried on with precision accuracy because the method now gives the advantage of using a thinner matrix material. It also permits reinforcement of the matrix against distortion and finally allows its perfect adaptation to cavity walls and margins by heavy swaging after each bake. Inlays constructed in this manner do not present a visible cement line; and since they are indestructible, their usefulness as a filling material depends primarily on the retentive factors of the cavity preparation.

## CAVITY PREPARATION

Certain well-known fundamentals apply to the preparation of all proximal and cervical margin cavities for porcelain inlays. The enamel walls of the cavity should make, as nearly as possible, a right angle with the tooth surface in order to avoid thin enamel or porcelain margins. This factor contributes to the esthetic values as well as to the strength of the restoration. Line angles should be avoided at the junction of the enamel walls in order to facilitate adaptation of the matrix. Line angles at the junction of the axial wall can be made more acute in order to deepen the enamel walls, thus increasing retention. The retention afforded by two opposing parallel walls is the least that can safely be used. The employment of two sets of opposing parallel walls, or a box-shaped cavity, provides maximum retention when the walls are of uniform depth.

The same rules apply to Class 4 cavities when they are prepared to include as much porcelain within the cavity margins as extends beyond the cavity margins.

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When this type of preparation is made impossible by extensive destruction of the labial wall, it becomes necessary to use some mechanical means of retention, such as pins or a gold casting.

Cavity preparation for proximal cavities in the anterior teeth is precisely the same as that used for the direct method, except in those cases where because of the time or other factors securing separation is precluded. When possible, adequate separation should be provided by the slow method. Orthodontic silk of various sizes is used to tie a wisp of cotton firmly between the contact points. In many cases, this one application is sufficient; in others, it is necessary to repeat the operation with a larger piece of silk and a larger pellet of cotton.

Ordinary hoes and Wedelstaedt chisels are the instruments most suitable for outlining the labial and lingual walls of Class 3 cavities. An inverted cone bur is used to prepare the gingival wall, and a round bur, the incisal wall. The labial, lingual and gingival walls are finished and the axial line angles deepened with angle-forming instruments of different width. These are ordinary hoes, except that the angle of the cutting edge is 85 centigrades instead of 50. The incisal wall is finished and its axial angle deepened with an ordinary hatchet from which the corners of the cutting edge have been rounded and resharpened.

The preparation of Class 3 cavities when separation has not been previously secured, or when only slight separation has been possible, is very similar to the preparation described above, except that the outline of the labial wall is not extended so far on the labial surface and the lingual wall is entirely removed, in order to facilitate the removal of the impression and the insertion of the inlay. The labial wall may be undercut at the labio-axial angle. The incisal and gingival walls are prepared with hoes and long enamel chisels. They must be made as nearly parallel as possible in order to secure maximum retention. The line angles formed by the incisal and gingival walls on the lingual surface are permitted to form a sharp right angle until the cavity preparation is almost completed. They are then rounded by deepening the axial wall with a small tapering fissure bur. A dovetail carried to the lingual surface is not necessary for the retention of these inlays. When retention is difficult to secure in cavities that have considerable length incisogingivally, it is possible to undercut the incisal wall. The gingival portion of the matrix is then removed first, and, of course, inserted in the opposite manner. Retention in the gingival area is secured by grooving the gingival wall of the cavity and by cutting an opposing groove in the gingival wall of the inlay.

The procedure for the preparation of a Class 4 cavity with separation is the same as for the Class 3 cavity, except that the incisal third or fourth of the axial wall is deepened in order to secure a retentive incisal wall. Care must be exercised to avoid the horn of the pulp. Additional retention is secured in these cases by preparing the labial and lingual walls more nearly parallel throughout their entire length. If separation has not been secured in a Class 4 cavity, the incisal two-thirds of the lingual wall is removed, the axial wall extending to the lingual surface of the tooth. The gingival wall is then countersunk with a fissure bur to give additional retention.

Class 5 cavities are prepared in the conventional manner, with particular care to make the gingival and incisal walls parallel in order to secure maximum retention. The four walls should be of uniform depth and the axial line angles slightly deepened, especially those formed by the union of the mesial and distal walls with the floor of the cavity. The largest size angle-forming instrument is excellent for the finishing of the gingival wall when it extends beneath the gum margin. If the gingival margin of the cavity is exceptionally deep, a wisp of

cotton impregnated with surgical cement is packed beneath the free gum margin with the intent of lifting it slightly away from the tooth surface instead of forcing it back, as is done by the use of a clamp. This pack should be left in place twenty-four hours before the preparation is made.

### IMPRESSIONS AND MODELS

When the indirect method of constructing both gold and porcelain inlays was first given serious attention, the materials in general use were modeling compound and amalgam. At that time and until recently, most model alloys were of low-silver, high-tin content, being so made to increase their plasticity. These materials shrunk excessively under all conditions and the shrinkage was considerably increased by overamalgamation during the mixing process. As a result, the use of amalgam as a model material has lost favor in the hands of a great many porcelain workers, at least for the present; but it is quite possible that manufacturers will soon furnish more specific instructions for the manipulation of the high-silver-content alloys now available. The use of amalgam and modeling compound will not be considered here because of this lack of information regarding amalgams and because modeling compound is difficult to manipulate in most porcelain inlay cavities.

Several years ago, a method of forming copper models by electrodeposition was introduced to the profession. These were found to be almost as accurate as the impression from which they were made. They had a crushing strength beyond the needs of our requirements and an edge strength much superior to that of any material now available. The profession is sufficiently familiar with the technic that it will not be necessary to describe it further, except to say that whatever material is used to brush over the surface of the impression in order to secure contact should be used in the thinnest film possible. Wax seems to permit the use of a thinner film than do the impression materials which require a light film of oil before the copper or bronze is applied. The oily nature of the wax itself provides a surface which is most adaptable to this method.

The technic for securing a wax impression of a Class 3 cavity is not at all difficult, provided a wax somewhat softer than ordinary inlay wax is used. A small piece of 0.001 platinum is selected and placed over the cavity. With a flat burnisher, the outline of the cavity is marked on the platinum. The platinum is trimmed to within 1 mm., or slightly less, of the cavity outline. This tiny platinum tray is used to secure the flange of the impression. A wax pattern is now made for the cavity. It is removed to make sure that sufficient separation has been secured and the direction in which it can be removed most easily is noted. If the contour of the pattern interferes with its removal, it can be trimmed away. The cavity is then lubricated and the pattern replaced. On the inner surface of the platinum tray, which has been dried thoroughly over the flame, a thin film of the same wax is melted. The tray is then carried to place over the wax pattern with the wax surface next to the wax pattern. It is held in place with a silk strip or a piece of rubber dam and burnished to close adaptation, then, with a warm instrument, the tray is heated sufficiently to soften both wax surfaces and, with pressure from the silk strip, these surfaces unite. The impression is chilled while under pressure with very cold water and removed by either touching the margins of the platinum tray with an explorer or by passing the explorer through the platinum tray into the body of the pattern. The impression is invested in a small patty of plaster and prepared for electrodeposition. It would not be safe to use a base metal tray in place of the platinum since the electrolite contains sulfuric acid, which would attack the metal.

When this same technic is used for the

impression of Class 3 cavities without separation, the flange of the platinum tray on the labial surface must be cut very short, so that the contour of the tooth will not distort the impression during removal. Slight separation makes the impression in this type of cavity less susceptible to distortion on removal.

Impressions for Class 4 cavities where separation has been secured are taken in the same manner. For those in which separation has not been secured, the wax impression is taken in a copper band, first with a very hard, high-heat inlay wax, which is thoroughly chilled with ice water, and then rebased with a thin film of softer, low-heat wax and again applied to the cavity with considerable pressure, which is maintained while chilling takes place. When the band is allowed to encircle the entire circumference of the tooth, the contraction of the wax under cold water might interfere with the removal of the impression. It is then advisable to follow the cold water with room temperature water before removal is attempted.

Class 5 cavities permit the use of a rebased wax pattern. They are also very adaptable to the use of modeling compound. In these cases, the tray is made of 36-gage, 24-karat gold plate, which is easily burnished to conform to the contour of the tooth. It is trimmed to fit uniformly beneath the free gum margins and to extend 1 mm. or more beyond the margins of the cavity. The tray is reinforced on the outer surface with a generous piece of low-karat gold solder. A shallow dimple is cut in the center of the outer surface with a No. 5 or No. 6 round bur to prevent the instrument from slipping when pressure is applied to the tray. The wax is seared to the inner surface of the tray and shaped to form a cone. The point of the cone is introduced into the cavity, and the gingival edge of the tray carried under the free margin of the gum and maintained in position with steady pressure. Care should be taken not to overheat the wax or compound before introduction into the cavity. Pressure should be applied thirty seconds before chilling is begun and maintained until chilling is complete. If these rules are followed, an impression may be secured that will show little volume change, but the careless manipulation of plastic impression materials will often have very discouraging results, since some waxes shrink as much as 3 per cent in volume during the process of manipulation.

Just recently, George M. Hollenback devised a technic for securing impressions that show no volume change whatever. With his permission, it is included in this paper: Tin foil 0.003 thick is placed over the cavity, outlined and trimmed, a flange of 1 mm. or more being left beyond the cavity margins. The foil is then burnished into the cavity while being held in place with a silk strip. Wet spunk or cotton may be used to adapt it to the floor and the deep angles of the cavity. Additional trimming of the flange should then be done in order to facilitate removal from the cavity, the operator noting the direction in which removal can best be made. The foil is then replaced, readapted and filled with inlay wax, which is thoroughly chilled under pressure. The smooth surface of the foil will not permit sufficient adhesion of the wax to cause any distortion in the foil in the event there might be a volume change in the wax; hence, we have a perfect impression. This technic can be adapted to all classes of cavities.

The use of tinfoil for an impression of this type limits us to the use of cement for the model. Cements have certain advantages as model materials and one chief disadvantage, which is shrinkage. The popular model cement known as kryptex is a combination of zinc-oxide and silicate cement having an exceptionally high crushing strength. When this cement is cast in an impression by centrifugal force and the resulting model compared with metal models under the microscope, it is

very apparent that the cement model presents sharper margins and greater detail. On the other hand, its dehydrating property and resulting loss of water is responsible for considerable shrinkage.

In order to determine the amount of this shrinkage and its possible control, I was prompted to carry on a series of experiments with model kryptex in the hope of developing a definite technic of manipulation. The results of the experiments are as follows:

Samples of the cement were made between strips of plate glass held apart by one-quarter inch steel gage blocks secured in position with small clamps. Oil paper was used underneath the blocks and the sixth side was left exposed to the air, in order to simulate the condition that exists when a model is made.

It was found that the immersion of the samples in water immediately after the initial setting period would prevent further shrinkage. It did not compensate for the shrinkage that had already occurred. It was therefore necessary to determine what condition caused, or would prevent, the initial setting volume change. This was found to be the proportion of powder to liquid. Heavy mixes shrunk in ratio to the increased amount of powder in the mix. Very thin mixes proved to be lacking in crushing strength and were too long setting. The heaviest and therefore strongest mix, showing no shrinkage, was made by using 1 gm. of liquid (by weight) to 1.6 gm. of powder. Half this quantity is sufficient for the average inlay model.

The mix should be made in forty-five seconds on a slab at approximately 74° F. It should be allowed to set undisturbed for fifteen minutes and, without separating, it should be placed in water. The model will expand as much as 0.2 per cent of its volume, but will return to its original dimensions within two hours, at which time it is ready for use. The model now remains constant provided it is left in water and, when exposed during the construction of the inlay, should be covered with a film of light oil and replaced in water occasionally during the process.

### THE MATRIX

In the laboratory procedure, the many advantages of the indirect method become apparent. The first, and not the least in importance, is the possibility of forming the matrix in such manner that it takes the shape and character of an inverted tincup. This is accomplished by making the model small and mounting it high on the swaging ring, using excess compound and tapering it to form a cone, the apex of which is approximately one-half inch or more above the edge of the ring. The model is mounted on the apex of this cone. A rather generous piece of matrix foil is used and the excess folded down over the sides of the compound cone. The edge of the entire periphery is then folded up a turn or two in order to further reinforce the matrix against distortion.

Platinum foil 0.00075 thick may be used to advantage in this technic since it permits better adaptation. It is difficult, however, to stretch this thickness of foil sufficiently while burnishing to fill the cavity without tearing it considerably. A more practical plan is to dispense with burnishing just before the matrix tears and with a sharp lancet cut the foil in such a manner that swaging will carry the platinum to the walls and leave the opening in the floor only. A second piece of platinum can be trimmed to sufficient size to cover the floor and extend about halfway up the walls. This is carefully adjusted and swaged to place and the two pieces are sweat together with an oxy-hydrogen flame or tacked with 2,400 porcelain.

### BUILDING AND FIRING OF THE INLAY

Medium fusing porcelain seems to best meet the requirements of Class 3 and and Class 5 inlays because of its ease of manipulation and firing, and its tendency

to flow under heat. High fusing porcelain is recommended for Class 4 cavities because of its resistance to flow, which permits the restoration of an angle.

The consistency of the porcelain can best be controlled if it is mixed and left in a dappen dish. The mixing should be done with a small glass stirring rod while the dappen dish is held on a vibrator. This eliminates air bubbles from the mix.

The first application of porcelain should fill in the axial line angles, extend about half way up the cavity walls and thin to a very thin film on the floor of the cavity. Maximum condensation should, of course, be secured in order to minimize shrinkage. After each bake, the margins of the matrix may be reburnished and the matrix swaged. Should the porcelain fracture under swaging, it will re-fuse at the next firing.

The second bake should cover the entire floor of the matrix and fill the cavity about half full. Before firing, this application should be cross-cut in such a manner that each of the four segments will shrink and draw toward its respective wall.

In the third bake, the matrix can be completely filled and a slight excess of convexity be established. Before firing, the porcelain is ditched and cleaned away from the margins so that they may be reburnished and swaged after the firing. The remaining bakes are permitted to go to the margins, thus completing the contour of the inlay.

The least amount of porcelain used for each bake will reduce the possibility of distorting the matrix. Five or six bakes are none too many for the average sized Class 3 and Class 5 cavity. Firing can be done very rapidly so that not more than ten minutes is consumed in the firing of an inlay, even though six bakes are used. The furnace, with the door closed, should be kept idling at the maximum firing temperature of the porcelain in use. The inlay matrix should be placed on a small platinum tray made from a sheet of matrix foil. The door of the furnace is opened and the tray held in front of the door for approximately ten seconds in order to dry out the moisture. The tray is then placed on the edge of the muffle and allowed to remain for ten seconds while the volatile materials burn off. It is then placed in the center of the muffle or at the point of highest heat and the door closed. While the door is open, during these two operations, the temperature of the furnace will fall approximately 150 degrees, but will rise rapidly as soon as the door is replaced. If the maximum firing temperature is not reached within seventy or eighty seconds, additional current should be applied in order to reduce the firing time to a minimum. The last or glazing bake will require approximately thirty to forty seconds longer. A fire clay tray should never be substituted for a platinum tray if time is a factor, because it will take several minutes to bring the fireclay up to the heat of the furnace.

### SETTING THE INLAY

Where the color of the inlay is of importance, it is necessary to use a semi-translucent cement for setting. These cements require additional retentive features, which are secured by grooving the walls of the inlay with a knife-edged stone and undercutting the walls of the cavity with angle-forming instruments or a wheel bur. As inlays constructed on 0.00075 foil leave little space for cement between the walls, great care must be taken not to mix the cement too heavy. It should be applied to the cavity, and to the inlay as well. The inlay should then be seated with an orangewood stick, and in a Class 3 cavity, it can usually be wedged to place with a toothpick against the proximal tooth. At least fifteen minutes should be allowed for setting before excess cement is removed. The inlay should not require any finishing of the margins whatever.

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# CROWN AND FIXED BRIDGE PROSTHESIS

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SEVERAL years ago, I undertook to keep accurate records of all restorations that were made in the mouths of patients. The data included roentgenographic, clinical and dynamic tabulations. An endeavor was made, where possible, to study also any tissue reactions to unnatural or undue stresses. These were compared with the reactions of similar tissues in the same mouths under normal conditions. Such a study had unlimited ramifications. For the purpose of this presentation, discussion will be limited to the biologic and mechanical considerations of the fixed bridge.

While it is not the intention to review the histology, anatomy or physiology of the tissues and organs related to the subject of crown and bridge prosthesis, it is essential that we be able to establish as a permanent standard normal tissues and conditions by which individual deviations may be evaluated, either as self-corrective or self-destructive. If the broader idea of normality is established by a sane and sympathetic correlation of microscopic and clinical findings, we are less likely to be led astray by questionable theories and technics.

The idea of a definite standard or normal condition extends beyond that of tissues alone: it encompasses also the conditions under which they exist and react; the forces to which they are subjected, with their resultant strains, and their reactions under environmental changes.

During function, teeth exert certain forces on each other. The resulting strains of tension, compression and shear, or their combinations, maintain a healthy condition if the displaced teeth tend to return to their normal position or state. If they do not, two alternatives exist: the first is corrective, by adaptation to new environments; the second is pathologic. The difference between the pathogic and the physiologic reactions is not so much in the nature of the force, be it mechanical or otherwise, as it is in the degree of the irritation and the ability of the tissues to respond favorably to changed conditions.

The loss of one or more of the natural teeth generally creates an abnormal change with accompanying abnormal functions and forces. An increased load is placed on some teeth, while others suffer through a loss or diminution of function. The deleterious change from normality, while slow, is continuous, and may become progressively worse with the lapse of time. The chewing habits of the patient are frequently modified and further abnormalities may develop to the point where the entire dental mechanism is thrown out of equilibrium and effective use. If, on the loss of teeth, corrective means are immediately employed, little if any deviation from normal will take place. There is clinical evidence that, even in those patients in whom, owing to the absence of certain teeth, a definite injury has been already sustained, the mechanical and biologic responses were very favorably restored by correct crown and bridge prosthesis. Nature adapts herself readily to a new environment if the restoration is properly designed, constructed and maintained.

A fixed partial denture, or so-called

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fixed bridge, is not however, a panacea. Its use is not universal. It is indicated primarily for the replacement of one to three missing teeth. It may prove a failure when involving six or more teeth.

All teeth are not fit physically or biologically to serve as abutments for a bridge. The coronal portion of a tooth may not be sufficiently long gingivo-occlusally to afford proper mechanical retention for a bridge retainer. Likewise, the attachment of the peridental membrane may be insufficient or the amount of alveolar bone may be incapable of supporting the additional load of a bridge. Teeth otherwise acceptable may be disqualified as abutments because of malposition in the arch or insufficient root length and membrane attachment.

Many fixed bridges have failed because the length of the span between the abutments was excessive. Other failures may be attributed to an insufficient vertical distance between the crest of the ridge and the opposing occlusal surfaces. Such a condition does not permit of the required amount of metal for strength or the space necessary for a cleanable pontic.

Lack of complete mouth study casts and roentgenograms also contributes to failure in bridge prosthesis. An accurate and complete diagnosis is difficult without them; for when only a visual examination is made of the mouth, many factors elude detection.

The value of complete upper and lower study casts may be further enhanced for possible future use if accompanied by a complete record of the color of the natural teeth and a cast showing the facial contour of the patient. Photographs should also be obtained from anterior and profile views. Those who may have occasion fifteen to twenty years hence to construct complete artificial dentures for the same patients will appreciate what having such data for reference means both to the patient and to the dentist. The value of such complete records will also manifest itself in the event of plastic operations to correct facial deformities due to accidents.

We find that in mouths which are partially edentulous, the chewing habits of the patient are modified. The side having teeth is used to a greater degree than the one which is partially edentulous. The latter, because of partial disuse, undergoes physical, anatomic and physiologic changes. Normal contacts are lost or modified. Teeth move mesially or distally and, in some instances, gravitate or rise in their sockets. We find also that changes occur in the bone supporting those teeth where normal stresses have been reduced or removed.

In a study extending over a period of fifteen years at the University of Illinois, College of Dentistry, evidence is available that the poundage as recorded on a gnathodynamometer is gradually increased when partially edentulous mouths are restored with fixed partial dentures.

Another point frequently raised is the question of treated teeth. Should all treated teeth be condemned as bridge abutments, or are there indications for pulpless teeth? Our decision in this respect should be determined by the complete case history, together with the roentgenographic evidence of previously treated teeth present in that mouth. Certain systemic disturbances may, however, contraindicate additional root treatment.

A bridge should not be considered unless all oral pathologic conditions have been corrected and the remaining teeth restored to a normal state. The eradiction of all foci of infection is a distinct prerequisite to the placement of any type of bridge.

My observations lead me to believe that two abutment teeth should support one pontic. An exception is sometimes made in the case of a missing lateral incisor, where a cuspid only may be employed as the abutment. If two teeth are replaced, with two abutments, the occlusion should be normal, the teeth physically and bio-

logically sound and the patient's health generally good. Restorations replacing three or four missing teeth and employing only two abutments may be considered in those instances wherein the opposing denture is a tissue-borne, removable appliance. This is particularly true of the posterior region. In the anterior part of the mouth, favorable consideration may be given to such an appliance if it extends from cuspid to cuspid. We have many of the latter types on record which have responded favorably both mechanically and biologically.

Failure with any type of fixed bridge is primarily due to an improper diagnosis. Contributing causes are a disregard of tooth form and occlusion; absence of embrasures and interproximal areas; faulty occlusion; the presence of weak abutment teeth or an insufficient amount of bone, and, finally, a tendency to place too great an emphasis on the edentulous space and to attach too little importance to the fact that we are dealing with an impaired organ of the human body.

Although a thorough understanding of the anatomy and physiology of the oral tissues and mechanism is important, a knowledge of the mechanical requirements of the bridge and its component parts may not be disregarded; nor can we fail to take cognizance of the physical properties of the materials used in this phase of restorative dentistry.

That element of the fixed bridge which establishes a union between the abutment tooth and the prosthesis has been designated by various terms, such as attachment, abutment piece and retainer. Although a name *per se* is not important, for purposes of clarity this part of a bridge is designated as the retainer, and the supporting tooth as the abutment. The replacing tooth, or the suspended member of the bridge, is designated as the pontic, and that part of the bridge which unites the pontic to the retainer is designated as the connector.

An ideal retainer possesses four qualities: retention, prevention, proper structure and esthetic values. To be of permanent value, a restoration must not only replace lost form and function, but must also prevent future damage. The principle of extension for prevention is particularly important in the construction of bridge retainers. This principle does not excuse promiscuous cutting of tooth structure, but it demands extending the margins into immune or cleanable areas even at the slight expense of esthetics. Neither does this principle justify deep cutting of cavities, because of its associated dangers to the normality of the pulp. The first essential in the preparation of any type of cavity is pulp conservation.

During the various cutting operations, precautions must be taken not to overheat the tooth. The employment of warm water and cocoa butter on stones while cutting will minimize this danger to a large degree. Sharp burs and instruments are a requisite at all times. A frequent cause of pulp involvement may be found in the insufficient protection of a prepared tooth during the interval between its preparation and the placement of the finished bridge. Painting the prepared tooth with copalite varnish and the employment of a well-fitted temporary covering of metal, hermetically sealing the cavity, has proved very satisfactory.

Whenever we cut into a tooth, its normal structure is modified. It is essential that the casting reproduce the form and relationships of the tooth. At times, we modify the buccolingual dimension of a pontic by narrowing it; or we place supplementary grooves through marginal ridges to assist in the escape of food during mastication.

In any restorative appliance, esthetic values are desirable and should be sought for, but not at the expense of strength or immunity to decay. Esthetic considerations are more serious in the anterior region of the mouth. The two main of-

fenders against esthetics are the interproximal and the incisal display of metal. A judicious outline of the cavity margins with reference to the light source, together with the proper beveling of exposed metal, will reduce to a minimum the objectionable visibility of gold.

Fixed bridge prosthesis has undergone a definite evolution during the past two decades, particularly in the conception and development of bridge retainers and pontics. Formerly, most retainers were crowns, either with or without dowels, and it was routine procedure first to devitalize teeth; but today the greater number of bridge retainers used are of the intracoronal inlay or three-quarter partial-veneer cast gold types and are usually placed on teeth having vital, normal pulps. Occasional criticism is raised against this type of retainer. Such criticism, when justified, is directed primarily against those failing because of improper fit or of improper seating in the abutment or lack of proper parallelism with the other retainers. Often a mistake in diagnosis as to type dooms a retainer beforehand. Likewise, improper heat treatment of the metal spells disaster for a bridge. It is only the properly designed and constructed cast retainer that may be considered when comparisons and results are tabulated.

Of the intracoronal inlays at our command, the two and the three surface types are the ones generally employed. The mesioclusal or distoclusal inlay has a very limited application. Generally considered the weakest retainer, it may be employed with safety when used with a nonrigid connector to support a rest of the occlusal or subocclusal type. A two-surface retainer should not be united to a pontic with a rigid soldered joint. Certain modifications of cavity preparations will increase the retentive powers of this retainer. The principle of cutting the vertical cavity walls parallel or nearly so is important, as is likewise the use of the so-called "boxing" effect in the proximal portion of the cavity. The gingival wall is dropped so that an acute angle is established between the gingival and the axial walls; which helps to wedge the casting in place in the event of any tendency of the metal to flow. Additional retention is afforded in the form of a slight groove cut in the pulpal wall. The use of a 16 or 14 gage iridioplatinum wire-lock inserted between the buccal margin of the casting and the enamel wall acts as a wedge preventing the occlusal displacement of the inlay. Similarly, a pin-lock may be inserted through a three-quarter casting on the lingual surface between the cingulum and the gingival margin. The pin extends into the tooth about 1 mm. and is at right angles to the direction of displacement of the casting. The two-surface type of retainer is mostly used in a bridge replacing only one tooth.

Where more than one tooth is replaced, but not more than two, we have at our disposal the three-surface intracoronal type of retainer. This should be used only when the abutment has a sufficiently long clinical crown. It is contraindicated on short teeth and in those mouths which are very susceptible to caries. In addition to the principles set forth in the previously discussed retainer, it is suggested that the pulpal wall be not one plane, but a series of planes from mesial to distal aspect. When a treated tooth is employed, we believe it wisdom to protect the cusps with the casting. Too many teeth have fractured when such cusps were not protected.

When three or more teeth are replaced, we have available the three-quarter partial veneer retainer. It is sometimes used in the restoration of two missing teeth, especially if the bite is excessively strong. Because this retainer requires the least sacrifice of tooth structure for a maximum of retention, and because it may be used with equal satisfaction in the anterior and the posterior regions of the mouth, it has become one

of the most widely used in bridge prosthesis. In the anterior teeth, it is prepared without an incisal groove, the 45 degree incisal plane being used in the majority of cases. The principal retentive factors are the two axial grooves which are placed parallel to the incisal one-third of the labial surface. The gingivo-incisal convergence of the two grooves should not exceed 2 to 5 degrees. In fact, these should, as nearly as possible, approximate parallelism. A deep shoulder is not employed at the gingival line; instead, a narrow bevel is placed in the enamel. The axial walls of the preparation should also approximate parallelism if maximum retention is to be obtained. In the posterior teeth, the axial grooves generally parallel the long axes of the teeth. It has been found that, in the posterior teeth, the replacement of the axial grooves with typical "boxings" has given better results. Where the three-quarter retainer failed, the cause was either too great a convergence of the walls and grooves or the use of unsatisfactory gold alloys. Where proper alloys are employed, failure may be due to incorrect heat treatment of the finished casting.

Although it is not within the province of this paper to discuss all the types of full crowns available as bridge retainers, a word concerning the complete veneer gold crown may not be amiss. Those practitioners who have studied the possibilities and limitations of this retainer, and who have mastered the technic of correct preparation and construction, agree that there is still a place for it in dentistry. They have observed over a period of years the service which these restorations have rendered without jeopardizing the health of the patient. Failure of this retainer is due to an improperly prepared abutment or to a crown poorly constructed and placed. Supplementary retention may be obtained by channeling the mesial and distal axial surfaces of the abutment.

Pontics, as constructed and used today in the majority of cases, consist of two portions, one of baked porcelain, the other of cast gold alloy.

The initial consideration of an ideal pontic is tooth form. It is not advisable to construct the pontic larger than the original tooth. The gingivoclusal and the mesiodistal distances are established, but the buccolingual dimensions may be so modified as to reduce occlusal stress. If an examination is made of the buccolingual dimension of a natural molar or bicuspid, we find that the distance between the buccal and the lingual cusp points is approximately one-half the distance through the greatest buccolingual diameter of the tooth. In many bridges, the distance from cusp to cusp equals the greatest diameter of the tooth, and, as a consequence, we have a bridge in which the occlusal area has been considerably increased. Moreover, the cusp positions are in traumatic relation to the opposing teeth. To eliminate the possibility of such conditions, the pontics are narrowed by bringing in the buccal or lingual cusps. To further reduce the strain, the pontic is narrowed mesiodistally in the lingual one-half. This not only further reduces the occlusal area, but also automatically widens the embrasures, which permits the tissues to be stimulated during function and the restoration to be more easily kept clean.

From the contact points, the pontic tapers gingivally until the porcelain comes in contact with the gum tissues. No porcelain should ever touch the tissues unless it is smooth and highly glazed. It has been shown that of all the materials at our disposal, highly glazed porcelain is most compatible with the soft tissues. In fitting the pontic, I endeavor to bring it in contact with the tissues, without pressure. When properly shaped and placed, such a pontic does not produce inflammation. On the contrary, the gum tissue fits itself snugly around the porcelain. The porcelain, in these pontics, may be cone-shaped and have only a

point contact with the tissues; or it may have a small surface contact in the shape of a so-called saddle or ridgelap. Long cones placed in alveolar sockets immediately after extraction are not so common today as they were a few years ago. I am limiting the root extension type of pontic to the anterior teeth, and use it under these certain conditions only: There must be present a sufficient amount of residual alveolar process, and no danger of secondary infection. Also, the porcelain root should not extend into the socket to exceed one-fourth the original root length. It is preferable, however, to let sockets heal after extractions and then use the rounded tip or the modified saddle type of pontic.

The tip or cone-shaped type of pontic may be universally used in the lower arch. In the upper arch, owing to esthetic requirements, we are frequently forced to use the saddle type. This term is a misnomer, for this type does not saddle the ridge. Though slightly concave buccolingually, mesiodistally it is convex. Whatever type is used, care should be exercised not to have food locks at the gingival margin. This may be avoided by establishing a continuity of surface from the pontic to the adjoining gum tissues.

As the name indicates, the so-called stressbreaker, or nonrigid connector, permits a slight degree of individual movement to the abutment teeth. Where the retainers would not be subjected to maximum stresses, as in the average three-tooth bridge, it may be better not to inhibit the normal excursions of teeth; therefore, a nonrigid connector is placed in the anterior retainer. When two teeth are involved, as in a four-tooth bridge, a nonrigid connector presents greater problems. We have a choice of inhibiting this slight tooth movement by making the bridge fixed at both terminals or by using the stress-breaking connector. In the latter case, the posterior retainer must be made stronger. In such instances, it is possible that the leverage action on the posterior tooth overbalances any benefits which may accrue from the slight movement gained. One of the benefits of the nonrigid connector lies in the fact that the bridge may be set in two parts. Another advantage in its use occurs when one of the abutments is malposed, which frequently permits the placement of a bridge without a great sacrifice of tooth structure.

A simple occlusal nonrigid connector should not be used when that part of the bridge extending distally to it occludes with a tissue-borne appliance. The settling of the denture may result in the displacement of the lug. Neither is this type of connector indicated in four-tooth anterior bridges. Nature, it seems, readily compensates for slight inhibitions of tooth movement resulting from the fixation of a bridge.

I should like to mention two other important items. The first is the value and advisability of keeping an accurate and systematic clinical and roentgenographic "follow-up" record of each restoration. It should be routine practice to roentgenograph the teeth after a prosthesis has been cemented to place. Secondly, the patient should be recalled at regular intervals, at which times a complete clinical and roentgenographic examination should be made again. If any deleterious changes occur, the causes should be ascertained and corrections made before an irremediable condition develops. In the course of years, many data of inestimable value will accrue.

A careful examination periodically of several thousand patients has demonstrated that the principle of fixation as evolved in present-day fixed-bridge prosthesis may safely be employed in rendering our patients a health service.

185 North Wabash Avenue.

# THE IMPORTANCE OF MAINTAINING EFFECTIVE AND NORMAL OCCLUSAL RELATIONS OF THE JAWS AND TEETH IN THE DEVELOPING CHILD

By Howard E. Strange, D.D.S., Chicago, Ill.

THERE is a preconceived plan of anatomical relationships and the growth of the mandible and maxillae (the face in its entirety) to normal shape and contour is determined to a great extent by inherent factors. There exists a biologic concept that "force determines form," and through the action of dynamic and static forces we have a correlation of related parts as the result of normal functional activity during growth and development. Perfection, differentiation and correlation of structure are the result of function, and the functional forces work hand in hand with the inherent growth forces to definitely influence the morphology of the face and aid in the molding of the bones of the face and jaws into harmonious shape and contour. A conception of the human denture from the biological and mechanical standpoints and a correlation of this knowledge will reveal the importance of maintaining effective and normal occlusal relations throughout the life of each individual.

The units of the denture are placed in a mutual relationship to each other, a mechanical arrangement of form and relationship to one another that is self-sustaining and actively resistant against displacement. Arch design and form is nature's arrangement for stability and there is a relationship of the teeth in one arch to those in the opposing arch. In Figure 1 we observe the resulting malocclusion where one of the units has been displaced during growth and development.

There is an anatomical adjustment of structure evolved for the support of the maxillary denture against the forces of occlusal stress. The muscles of mastication are powerful activators that move the mandible in functional ranges and the stress received upon the occlusal surfaces when these muscles contract is disseminated throughout the basal bones in definite lines of force distribution. The upper jaw in its arrangement and adjustment is buttressed in all directions to receive the forces of occlusal stress.

Harmonious location and normal functional arrangement allow a just and equitable distribution of force and supply the demands for adequate functional efficiency of the masticating mechanism. Each dental arch possesses a definite form and a definite relationship to the opposing or associated arch and cranial anatomy. The associated supporting structures of bone and muscle are definite in their form, location, action and architectural composite. They are balanced in their force production, and are in a static and dynamic equilibrium in their composite arrangement. When one lateral segment of the denture is in function, the other

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side is out of function, and the whole mechanism is in reality divided into two halves. In the various ranges of function, there is not a continuous occluding contact of all the units of the denture. Figure 2 illustrates a malocclusion indicating lack of proper lateral development of the mandible. There is no balance of force production, and there can be no functional efficiency until conditions are restored to normal.

A study of some of the forces producing and maintaining normal occlusion, and how an upset in the equilibrium of these forces (intrinsic causes of malocclusion) operates to produce jaw irregularities will help us to realize the importance of maintaining effective and normal occlusal relations during the period of active anatomical growth and development.

Muscular pressure and the directing guidance of the teeth in apposition are particularly influential before and during tooth eruption. The axial inclination of teeth is determined and maintained to a great extent by a force that is called axial stress, a force that is exerted upon each tooth in a vertical plane. The axial positioning of teeth is also influenced and affected by the functional forces emanating from meshing and pounding of the occlusal inclined planes as well as by environmental muscular pressure and the pressure of the juxtaposed teeth. An analysis and study of the relationship of the occlusal inclined planes and the posi-

Fig. 1.—Collapse of mandibular denture probably caused by too early loss of deciduous molar or cuspid in lower right buccal segment. The lower right first and second permanent molars are situated mesially to the normal and a shifting to the right indicates a collapse of the incisors and cuspids and a displacement lingually and to the right, resulting in lack of adequate space for the lower right second bicuspid.

Fig. 2.—Malocclusion indicating lack of lateral development of mandible.

tion of the crowns of the teeth in relation to their roots in a vertical plane (axial inclination) will give us a more definite picture in assessing proper growth and development of the dental arches. (Fig. 3.)

In making a periodic examination of the growing child's teeth and jaws we must visualize the related parts in three dimensions or planes of space, and the importance of this analysis may be summed up in the following points:

1. Whether the functional integrity of the arches has been maintained should be determined.

2. Axial inclination of the teeth would aid in indicating whether or not the occlusal inclined plane relationship is correct. Usually where there is not a proper inclined plane relationship, there is a deviation in axial inclination. (Fig. 3.)

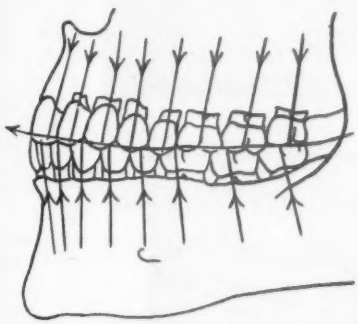

Fig. 3.—Axial inclination of teeth, indicated by vertical lines, which also represent component force of each unit of upper and lower denture meeting in line of occlusion. The meeting of these two components resolves itself into a forward force.

3. Whether there has been a drifting or tipping of teeth or segments of teeth in an arch, particularly in a mesial direction, should be determined. (Fig. 4.)

4. A break in the cuspid-lateral incisor area, accompanied by an excessive mesial incline and mesial drift of the teeth in the buccal segments, would indicate improper axial inclination and an evident malocclusion and improper growth and development. (Figs. 4, 5, 6 and 7.)

5. There is a normal degree of axial inclination within certain limits and any deviation from the conceived normal indicates that there is an upset in the balance of the denture and related parts in function. (Fig. 3.)

Referring to point 4 and Figs. 4, 5, 6 and 7, if a two-dimensional analysis is made of the cuspid-lateral incisor area, an expansion program to make proper alinement of the teeth would seem to be indicated. If such a program of treatment of these cases were undertaken, how could the anterior part of the maxillae and mandible support and permanently accommodate the teeth from cuspid to cuspid? If the buccal segments are mesial to normal, and the teeth in the buccal segments are in an excessive mesial axial inclination, what is there to prevent a recurrence of the same buckling or overlapping after the retaining appliance has been removed?

Perspective is necessary for an adequate analysis, and in making a three-dimensional examination our plan of orthodontic management would be changed considerably. The buccal segments must be moved in a distal direction in order to provide adequate space for the proper alinement of the teeth in the anterior segment of the arch. In moving the buccal segments in a distal direction an automatic expansion is accomplished, and in following out such a program of management proper axial inclination of the teeth may be established.

In a short paper, we can only deal with a few of the biological and mechanical fundamentals governing effective and normal occlusal relations and time does not permit an analysis of the two great functional forces or normal functional acts in the production and maintenance of normal occlusion, mastication and swallowing. There is a pull and pressure of the muscles in all the functional ranges

of mastication. The normal mesial axial inclination of the buccal teeth (particularly the molars) meeting one another, an upper with a lower, in a series of angles directed forward, produces a forward propelling force associated with the meshing and grinding of the inclined planes. This force acts forward or is disseminated forward through the contacts in a straight line (Fig. 3) and is a resultant force produced by the meeting of the two vectors of force in a vertical plane.

The anterior resultant force is important in that it (a) aids in the forward growth of the denture, (b) aids in the lateral growth of the denture (tangent forces laterally) and (c) helps maintain constant and active proximal contact of the teeth. There is a muscle mass existing to resist this anterior propelling force and prevent a break in the cuspid-lateral incisor area where this anterior force emerges. The muscles associated with the lips and cheeks, viz., *buccinator, triangularis, caninus, zygomatic, quadratus labii superiores* and *inferiores, mentalis* and *orbicularis oris,* exert a strong muscular pull upon the denture and its basal supports in a posterior direction. Improper activity of these muscles will upset the balance of the backward force or pull, and will usually first be detected in the cuspid area. The anterior resultant force will not be balanced by this backward pull and there will usually be a buckling in the cuspid-lateral incisor area. (Figs. 4, 5, 6 and 7.)

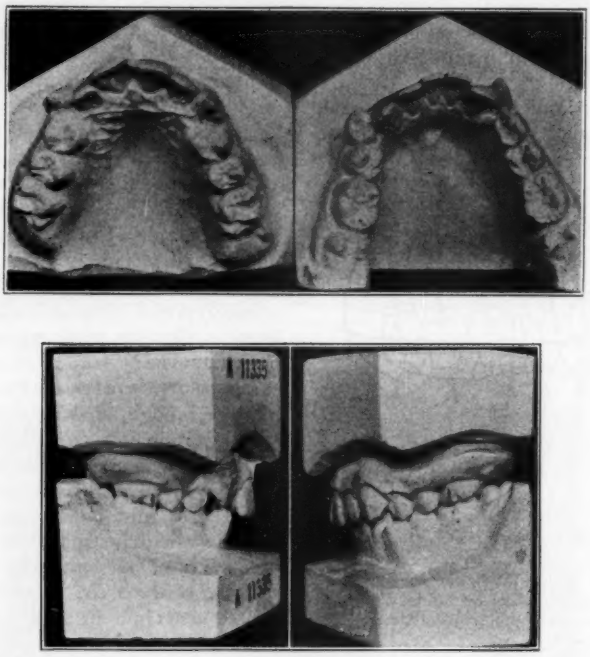

Fig. 4.—Mesial drift of upper right and lower left and right buccal segments. The excessive axial inclination of the upper right cuspid, lower right cuspid and lower left first bicuspid would be an aid in case analysis.

The muscle mass in the front part of

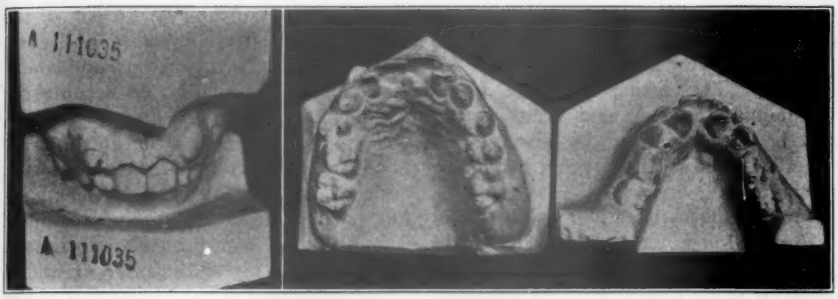


Fig. 5.—Irregularities caused by too long retention of upper deciduous cuspids and lower second deciduous molars. The crowns of the upper cuspids are directly over the lateral incisors, and there is a tendency toward a mesial drift of the lower buccal segments. There has been a mesial drift of the lower buccal segments, and the lower cuspids are almost in contact with the central incisors.

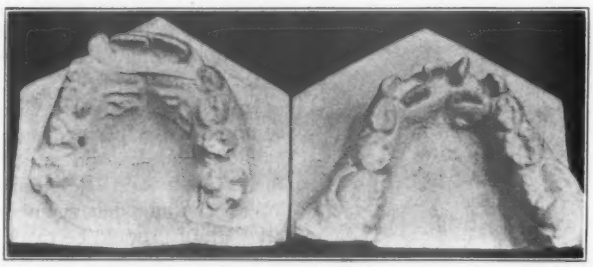

Fig. 6.—Case in which careful analysis indicated that buccal segments, upper and lower, have drifted mesially. This condition is often confused with lack of expansion.

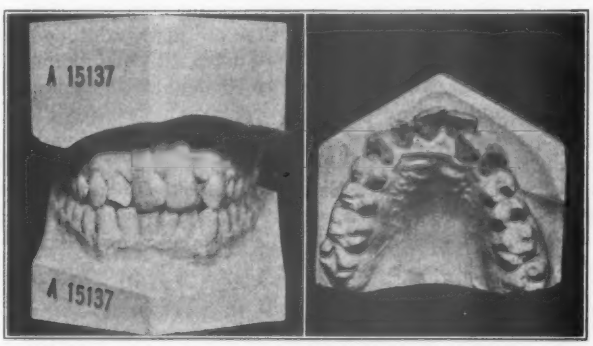


Fig. 7.—Case in which mesial drift of upper right buccal segment, indicated by upper median line (left), pushed crowns of central incisors to left. The integrity of the arch has probably been destroyed by the too early loss of deciduous teeth, and there is a lack of adequate space for the lateral incisor. The position of the left lateral incisor is only a part of the picture, and an expansion program of treatment will not afford adequate space. The teeth in the segment must be shifted in a distal direction for proper alinement of the teeth in the anterior segment.

the denture working with the buccinator and exerting a backward pull prevents the denture from being carried too far forward. The action of these forces maintaining balance and arch support can be best described by arranging a series of balls in the arrangement of a dental arch.

Hitting the balls at No. 1 will propel a force through the contact of the balls that will force the No. 3 ball (the cuspid) to go off in the direction of the indicated

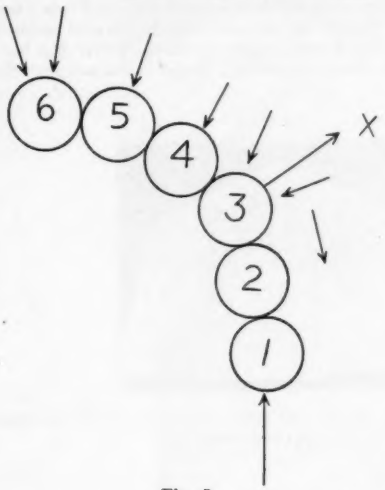


Fig. 8.

arrow X. Now think of these balls as teeth in bone with backward forces against Nos. 3, 4, 5 and 6, through the muscles exerting a pull in a posterior direction. A definite balance is maintained, and the teeth are kept in proper contact relationship in order to prevent a collapse of the arch and a drifting of teeth or segments of teeth. The zygomatic muscles prevent a shift of the anterior part of the denture in a lateral direction, and exert a balancing pull in a backward and lateral direction, thereby aiding in keeping the cuspids (the keystones of the arch) in a proper position and relation in the arch. The buccinator muscles are directed back along the sides of the arch into the buccopharyngeal fold (pterygo-mandibular raphe) which in turn blends into the superior constrictor of the pharynx and is attached in part to the basilar part of the occipital bone. The tie-up of all these muscles in normal function will exert a backward force or pull on the denture and basal supports. We evidence the action of these muscles in the act of swallowing and that one action alone activates these muscles in a backward direction and aids in maintaing balance with the anterior resultant of force.

In order to properly visualize a clear comprehensive perspective of occlusion (child or adult) and periodically check the growth and development of the arches, study models, roentgenograms and photographs should be made at intervals. A series of records of this type will enable the observer to study the occlusion in three dimensions and thereby detect deviations in their incipiency. The described factors are only part of the picture, and there are many additional factors of importance in maintaining balance in growth and development of the arches. All these factors obtain throughout the life of the individual and a knowledge of the various important points enables us to more effectively minimize these adverse conditions of life that tend to shorten the period of dental efficiency.

2376 East Seventy-First Street.

THE JOURNAL *of the*
AMERICAN DENTAL ASSOCIATION
*and* THE DENTAL COSMOS*

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*In deference to the wish of the dental profession to control its literature, *The Dental Cosmos*, founded in 1859, was transferred by the publishers as a gift to the American Dental Association, January 1937.

## *Editorial Department*

# THE BENEFICENCE OF DENTURE RESTORATION

THINK of the pathetic plight that would confront countless thousands of our fellowmen were it not for the genius that throws itself into the breach and rescues humanity from the appalling disaster of being condemned to face a toothless old age.

We have frantically tried to snatch the natural teeth from the impending doom of decay and disaster, only in too many instances to be forced back beyond the ramparts and left prone in the humiliation of defeat. And what may not this defeat mean to a human being!

The teeth are an integral part of the mouth, and the mouth is one of the most important and imposing structures of the face. The face is the most conspicuous feature of the human anatomy, exposed everywhere for the observation of men, and thus the link leads directly from the first imperceptible break in a few enamel prisms on down the line to the ghastly void left by the loss of the natural teeth.

And after that, what? Never in all human experience has a wreck been more apparent or pitiful. The shock to symmetry; the hideous grin; the bleak hole; the uneasy tremulous tongue with nothing to guide it, seeking like a lost soul for companionship; the distortion of countenance; the forlorn and pointed chin groping for the nose; the shrunken jaws, and the quavering uncertain threat of senility, leaving the hapless victim bereft of function and of hope. The utter helplessness and despair; the defeat and humiliation; the sense of bereavement and deprivation; the unfairness; the assault on the sensibilities, and the cruel and crucifying surge of unhappiness that threatens to overwhelm and crush out all human hope—this is the pathetic portion meted out when the teeth are lost.

Then happily, in the midst of all this ruin, comes the deliverer. A magician waves his beneficent wand across the countenance of this human wreck, and lo and behold, a miracle is wrought! It is greater almost than the fabled miracles of old. The shrunken jaws are rounded into fullness and artistic form; the telltale lines are smoothed away and banished from the eyes of men; the aching void is gone, and in its place the light falls, with rhythmic grace, on lips made youthful by the wizardry of art. The contour of the face is restored; old age has been swept aside, and in its place has bloomed the promise of perennial hope and rehabilitation.

The benison of art for once has triumphed over the handicap of fate, and rescued a despairing soul from the grief and woe of disease and deformity. During all the days to come, the time shall never be again when humanity is helpless in the face of nature's cruel wreck.

In the countless enterprises of men, not one is of greater moment than this, not one where genius so valiantly stays the hand of devastation and despair. No other kind of regeneration is more vital, no service more beneficent, and no relief more happy.

All the stress and strain of burning the midnight oil, all the patient plodding of earnest souls, all the doubts and disappointments, all the gleams of hope and promise—all are as mere incidents in the one stupendous fact that this marvelous achievement has been consecrated and laid on the altar of science and of art.

Whenever any man, scientist or layman, seeks to belittle our calling, as some seem prone to do, might it not be meet that we weigh in the balance against this aspersion the magnitude of the blessing that has been vouchsafed to humanity through the regeneration wrought at our hands?

If dentistry met no other need than this, it would justify itself in the eyes of the world, and make valid claim as one of the great professions.

# THE BROADENING SCOPE OF DENTISTRY

THE determination to develop dentistry as a separate and distinct branch of the healing art owes its origin to the recognition by dental educators of the fact that any plan of dental education that does not provide for training in the skilful production of dental mechanisms as well as dental operative procedures must defeat its own objective; and the success of dentistry in the past as well as in the future depends upon the intelligent application of that principle to the dental educational system.

There were those in the early days of dentistry and through the intervening years, and even now, there are those who believe that dentistry should be a specialty of medicine; in fact, this question is as old as dental education, and subject to periodic efforts at revival by those, even in the dental profession itself, who profess to believe that medical training leading to the medical degree comprises the only adequate preparation for the practice of any phase of the healing art. Dentistry as a separate and autonomous profession owes its very existence to the failure of that idea to prevail among those early pioneers of dentistry who advocated the development of dental practice along broad but strictly dental lines.

In fact, the reaction to the efforts to direct dental education from the medical aspect has been distinctively to broaden the scope of dental practice, and with notable success, supported by the demonstrations of Miller and Hunter of the part which dental conditions may and do play in many serious systemic conditions and vice versa.

The reaction to the importance of these interdependent disease relations has been almost exactly opposite in dental and medical circles; in dental circles it has evolved a stronger determination to maintain the autonomy of dentistry; in the medical circles it has resulted in a recrudescence of the antiquated conception of dental education and practice which time and experience have long since proved erroneous, namely, that dental education should be superimposed upon the medical course, and that dental practice should be enveloped by medical practice.

For more than two decades, now, the energies of some dental educators, or should we say propagandists, have been largely directed toward efforts to compel the development of dentistry on the same basis as that of the formal specialties of medicine; so much so, that we have at times become mildly alarmed at the possibility of losing our autonomy if we follow blindfoldedly the lead of those who are deceived by the

dentomedical will-o'-the-wisp. Chief among the many reasons for maintaining our autonomy is the inherent difference between dental service and the service of the specialties of medicine. We refer particularly to the technical nature of dental practice as it has been developed and is being practised today.

Paradoxical as it really appears, this technical aspect of dental practice has been the principal factor in determining the character, form and content of the dental curriculum, the factor responsible for the autonomy of dentistry, the factor that precludes the possibility of dentistry becoming a specialty of medicine, and yet the factor that has enabled the dental profession to enlarge its scope to the extent of compelling recognition of its skill and adaptability in the oral surgical field.

The technical skill developed in the professional dental course is a necessary requisite of the skilled surgeon as was abundantly demonstrated in the aptitude of the oral surgeon to assume full responsibility for the care of oral and maxillo-facial conditions that had resulted from gunshot and other wounds during the World War.

From that time particularly, the position and status of the oral surgeon have been developed largely from the dental approach and his work has become a necessary part of the healing art, and a necessary adjunct to the rendering of a complete health service.

In our eagerness and determination to attain medical status, let us not be so far diverted from the strictly dental path that we may become medical dentists. Let us take from medicine all that is necessary and desirable for a full and scientific understanding of the surgical needs of oral surgery but not at the sacrifice of dental technical knowledge and skill. Let us continue to demonstrate the fact that the graduate from the dental course is better prepared to practise his profession at the completion of his undergraduate study than is the aspirant for any of the formal specialties of medicine. Let us continue to demonstrate the soundness of the conception of dental education in America as contrasted with the general conception in Europe of dental education developed from the medical aspect.

In this development, however, it is quite likely that we shall accomplish our aim without the sympathetic aid of medicine. This indifferent, if not antagonistic, attitude on the part of medicine is much to be regretted at this time, as it is more necessary now than ever, in view of enlarged responsibilities that will likely be forced upon medicine and dentistry by virtue of the development of the social security ideal, that dentistry and medicine work hand in hand. At the present moment a

most favorable opportunity for helpful and beneficial cooperation between the two professions presents itself in the elaboration of the dental internship.

Rather reluctantly has the medical man acknowledged the dental intern or the necessity therefor, but wherever the dental intern has been allowed to work in his naturally prescribed field, he has convincingly demonstrated his usefulness in the general health scheme.

Not only has the dental intern proved his ability to assume his share of actual oral surgical responsibility but he has proved beyond doubt that dental care in the hospital is an important and indispensable aid in the control of systemic disease as well as in promoting more rapid recovery and in materially reducing the incidence of relapse.

It is only within the past few years that the medical profession and the hospitals have begun to recognize the desirability of dental internships, to the great advantage of the patient, the hospital and the dentist. From no internships not so many years ago, dental internship has now become almost the universal custom, and to follow the idea to its logical conclusion, we shall in a few years require hospital internship from all dental graduates, and we are sure with definite and positive mutual advantage to all concerned.

The natural broadening of the scope of dental practice in directions other than surgical may be illustrated by citing but a single example at this time—that of the influence of the changing relations of the temporomandibular articulation upon the organs of hearing. It has been shown by numerous dental prosthetists that the normal wear of the teeth under the functional stress of mastication brings about definite changes in the occlusal relations of the denture—a so-styled closing of the bite—that results in anatomic impingement upon the organs of hearing.

This anatomic relationship of the temporomandibular articulation to the organs of hearing is well portrayed in an article in our present issue by Dr. H. L. Harris, entitled "Effect of Loss of Vertical Dimension on Anatomic Structures of the Head and Neck," together with a most intelligent technical procedure for reestablishment of normal anatomic relations of the organs of hearing and those of mastication for the relief of this distressful disturbance of the sense of hearing.

Dr. Harris and a number of his confreres are doing much to demonstrate the vital relationship of the masticatory organs to other organs of the body and in a manner calculated to broaden in a very significant degree the scope of dentistry as an important branch of the great healing art.

L. P. A.

# ASSOCIATION ACTIVITIES

## COMMITTEE ON LEGISLATION

### ARMY DENTAL CORPS LEGISLATION

As THE JOURNAL goes to press, word comes from Dr. Charles D. Cole, Washington, D. C., that Senate Bill 2463, providing for substantial increase in officer personnel of the Army Dental Corps, and further providing for the rank of Brigadier General for the chief of that corps, was adopted by the Senate on January 15th. The House of Representatives must concur and the President must sign this measure before it becomes a law. We are confident this will be done.

The adoption of this measure is of first importance. Sponsored by the American Dental Association, it directly concerns the dental profession, the health program of the Army of the United States and the welfare and efficiency of the Army Dental Corps.

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A TABULATION of the "statutes of limitations" in the various states and the District of Columbia has been arranged by the Committee on Legislation, as these state statutes affect actions for malpractice against dentists, and this information is available on request.

Ordinarily, only those statutes limiting actions for personal injuries would apply to malpractice suits. However, the courts have, in a few instances, allowed malpractice actions based upon a contract theory.

The statutes relating to assault and battery are inextricably connected with malpractice actions in several states, and several statutes expressly mention malpractice among the personal injury actions which are limited, but these do not prevent actions on a contract theory unless the state courts have construed them as impliedly barring such actions.

Colorado, Iowa, Massachusetts, Minnesota and South Dakota have statutory provisions which expressly limit actions for malpractice whether based upon contract or upon tort (any wrong, injury or damage not involving breach of contract).

These are the most complete and adequate protection for the professions because the suit must be brought within a reasonable time and the contract limitation period cannot be used.

A. B. PATTERSON, *Chairman,*
Committee on Legislation.

IN THE CIRCUIT COURT OF THE STATE OF OREGON FOR THE COUNTY OF MULTNOMAH

GEORGE M. HOFFMAN,
Plaintiff,
vs.
O. J. JOHNSON, E. L. BRUNK, WILLIAM E. MOXLEY, A. E. GREENHALGH, and ARTHUR F. WEEKS, constituting the State Board of Dental Examiners of the State of Oregon, and ARTHUR F. WEEKS, Secretary of said State Board of Dental Examiners of the State of Oregon,
Defendants.

No. 126-059.
MEMORANDUM OPINION.

This cause is before the Court upon a writ of review. The Accusation and Complaint charges Dr. Hoffman with holding himself out as practicing "Industrial Dentistry"; that he stated in letters to his patients and the public as follows:

"Hereafter when you step out of our dental chair having experienced the comfort of ANALGESIA, you will bless its inventor, and you will feel kindly toward us for being so up-to-date in our equipment and methods."

That he further stated in letters to the public:

"In our dental offices you now can have a tooth drilled without submitting to 'sleeping-gas' or even the prick of a novocaine needle or any bad physical after-effect. As dentists, we feel greatly relieved to be able to make this agreeable announcement."

Accompanying the letter was an advertisement from the *New York Sunday Mirror* which stated:

"The latest vogue in town at this and that dentist's is a grand anaesthetic, 'Analgesia' it is christened. They use it while drilling and filling. The patients administer the gas themselves. It merely makes them 'feel high' or drunken—and they feel nothing. Bless the person who invented it."

That he also stated in letters:

"One demonstration of ANALGESIA during the month of February without charge."

The charge was filed against Dr. Hoffman and he had a hearing before the Board of Dental Examiners. The Board found that this advertising matter was in violation of the law and issued an order suspending Dr. Hoffman for a period of six months.

Dr. Hoffman freely admitted writing the letters, and it is the Court's opinion that by writing these letters the Doctor violated the law by advertising professional services in a superior manner.

The Court is further of the opinion that the Doctor did not violate any law by stating to the public that he was engaged in "Industrial Dentistry." This is not prohibited by any statute.

The order of the Board also provides that Dr. Hoffman desist from the practice of dentistry personally and through any agent or agency; that he withdraw his name from any and all kinds of advertisements, including circular letters; that his name be removed from the door of his present office and from the building directory where his office is maintained. The Court is of the opinion that the Board exceeded its authority in requiring the Doctor to remove his name from the door of his office.

The Court is also of the opinion that Dr. Hoffman did not intentionally violate any law. However, our Supreme Court has held that it is wholly immaterial whether the Doctor intended the consequences of his acts or not.

For this reason the writ will have to be quashed. However, the order may provide that the Doctor need not remove his name from the door of his office.

Should Dr. Hoffman desire to appeal to the Supreme Court the Court will grant an order to stay proceedings until this case has been determined by the Supreme Court.

Dated this 3rd day of January, 1938.

(Signed) JOHN P. WINTER,
*Judge.*

# BUREAU OF PUBLIC RELATIONS

## THE AMERICAN DENTAL ASSOCIATION NATIONAL POSTER CONTEST

THE response to Dr. Camalier's request that a national dental health poster contest be held has been very gratifying. To date, thirty states, either in whole or in part, have signified their intention to participate.

The following states or districts thereof are cooperating: Arkansas, California, Colorado, Connecticut, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Missouri, Nebraska, New Jersey, New York, North Dakota, Ohio, Pennsylvania, South Dakota, Tennessee, Texas, Wisconsin, West Virginia, Maine, Minnesota and Oregon.

Over 60,000 copies of the poster rules have been distributed by component society poster contest chairmen in the city and rural schools in their districts.

A certificate of award, an illustration of which accompanies this article, will be given by the American Dental Association to the first, second and third winners of each group in each district or component society contest.

The following excerpts, taken from a few letters, are typical of many received:

The Fresno District Dental Society is vitally interested in the National Poster Contest and you can depend on us to carry out our part.

T. H. SORENSEN, *President,*
Fresno (Calif.) District
Dental Society.

The teachers of Ohio County are interested in the Dental Poster Contest. Please send us enough material on dental health literature for ten rural schools.

GOLDIE SHANAHAN,
*Superintendent of Schools,*
Rising Sun, Ind.

I have been in conference with our state commissioner of health and the superintendent of schools in Hartford, and from these contacts I am led to think that this poster project as outlined to these leaders is likely to be received and developed in a big way. We are besieged with requests for further information.

E. HARVEY RICHMOND, *Chairman,*
Dental Educational Committee
of Connecticut,
Hartford, Conn.

We have mimeographed copies of the rules and regulations which govern the contest and have mailed a copy to the county superintendent of schools and to each officer of the ninety-nine county dental societies in the state. We have requested the county school superintendents to mimeograph the rules and regulations and to supply a copy to each town and rural school of their respective counties.

O. E. HOFFMAN, *Chairman,*
State Poster Contest Committee,
Iowa State Dental Society.

I find that my activity in the Poster Contest is broadening to such an extent that I must have a great many more reprints of the rules and regulations.

N. H. BAKER,
Charleston, W. Va.

Our pupils have already made posters for the Dental Poster Contest. It was necessary to make them early so as not to conflict with

other posters which are called for in the spring.

VIRGINIA A. EBERLING, D.H.,
Canonsburg, Pa.

The Tennessee State Dental Society and all of its components have passed the following resolution:

WHEREAS, Mouth health is a vital factor in the incidence of general health, and is so recognized by the medical and dental professions;

WHEREAS, the American Dental Association adopted for its meeting held in Atlantic City in 1937 the slogan, "Preventive Dentistry in the Interests of Health"; and this year the theme "Dental Health for American Youth," for the purpose of more thoroughly educating parents and children in preventive measures designed to minimize dental diseases of youth in the present and future generations; and

WHEREAS, the Tennessee State Dental Association, a constituent of the American Dental Association, recognizes the extreme importance of this move in the interests of the children of Tennessee; be it

*Resolved,* that the Tennessee State Dental Association enthusiastically endorses this program of the American Dental Association and pledges its whole-hearted support in the carrying out of the purposes thereof; and be it further

*Resolved,* that a copy of this resolution be forwarded to the Commissioner of Health of Tennessee, the dental health officers, the president of the state board of education, the officers of the nine district dental societies of Tennessee, the Surgeon General of the United States Public Health Service and the Officers of the American Dental Association.

Officially certified to:
E. J. JUSTIS, *Secretary-Treasurer,*
Tennessee State Dental Association.
Approved: November 7, 1937
Place: Hermitage Hotel
Nashville, Tenn.

The Mt. Baker District Dental Society, which is composed of the members of the Association in Whatcom, Skagit and San Juan Counties, Washington, has practically completed its plans for the educational program of 1937-1938. We are working along the lines of the American Dental Association's slogan "Dental Health for American Youth." We will follow the rules for the poster contest in the schools of the cities and rural districts.

J. WARD FINLEY, *Chairman,*
Health Committee.

The Illinois State Dental Society organized their state poster contest on a very comprehensive basis as reported by Charles F. Deatherage, chief of the Division of Dental Health Education, Illinois State Department of Public Health.

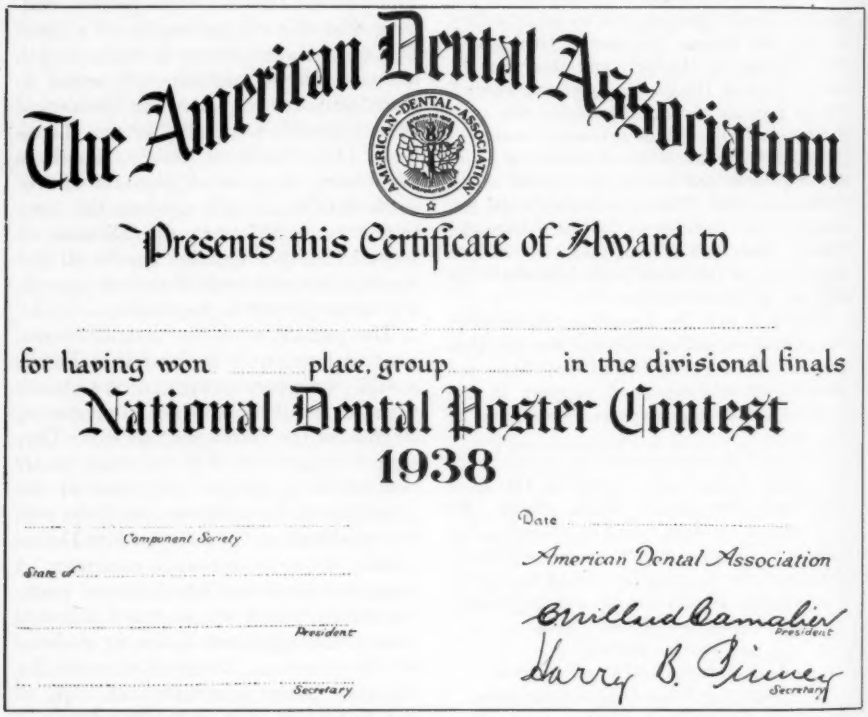
The Committee on Dental Health Education of the Illinois Dental Society, realizing that this contest would do a great deal to promote interest in dental health among children, unanimously voted to participate and requested the Division of Dental Health Education of the Illinois State Department of Public Health to cooperate. Because of the amount of work entailed in this project, the committee requested that the Division of Dental Health Education handle all correspondence and keep all records pertaining to this project in the division.

The presidents of the various component societies were notified that Illinois would participate in this contest and were urged to use their influence in promoting interest in the component society. They were also notified that the state poster committee would be composed of the presidents of the component societies with the president of the Illinois State Dental Society acting as honorary chairman. A suggested procedure for the state poster committee, which was enclosed, followed closely the suggested duties as outlined by the American Dental Association for the state poster committee. A copy of this letter was sent to the secretaries of the component societies.

A letter was sent to the secretary of each component society urging him to plan a special meeting the latter part of March or the first of April, at which time the posters of the component should be judged. Attached to this letter was a questionnaire asking the secretary whether it would be possible to hold such a meeting, and if so, to give the date and place.

If it is not possible to hold such a meeting, the secretary is asked to give the date and place of their last regular meeting preceding the annual meeting of the Illinois State Dental Society in Peoria in May. This information gives the date when the posters in the various components or districts should be completed.

The staff members of the Division of Dental Health Education, consisting of four dentists and four dental assistant nurses in four dental health districts, were notified of Illinois' participation. They were instructed to discuss this contest with all health officers, county or city nurses, lay organizations, superintendents, principals and teachers whom they contact and to leave suggestive material and printed copies of the contest rules. They were also instructed to keep an accurate record of all schools participating. In discussing this contest with the school officials and teachers, particular emphasis is placed on the importance of the teachers arranging for each child to make a poster. When these posters are completed, the teacher, or whoever she deems advisable, should judge and select the winning posters. The winning posters of each room then should be judged for the winning posters of the school. Many towns and cities are conducting this type of contest and the various lay or civic organizations have agreed to sponsor prizes for their respective schools. The county superintendents are urged to have each teacher in their counties make posters along similar lines, the winning posters


The American Dental Association

AMERICAN · DENTAL · ASSOCIATION

Presents this Certificate of Award to

.....

for having won ..... place, group ..... in the divisional finals

National Dental Poster Contest

1938

..... Component Society

State of .....

..... President

..... Secretary

Date .....

American Dental Association

Orville Banalier President

Harry B. Pinney Secretary

**Certificate of award presented by the American Dental Association to poster winners in the divisional contests.**

from each school to be sent to their offices for display until the component dental society contest. Some of the counties are planning a county contest to precede the component contest. The staff members are requested to send in each month a list of schools participating in this contest so that there will be available at all times the number and location of these schools.

Before the last component meeting, the teachers and school officials will be notified to send their winning posters to the county lieutenants, who will then be notified that they will receive posters from certain schools in their county. The county lieutenant will then send these posters to the component lieutenant for judging in the component dental society contest. The component lieutenant will send the winning posters from his component contest to Peoria in May for judging in the state contest.

The selection of the component prizes have been left entirely to the component societies, since they are in a better position to know the type of prizes that should be given in their respective districts. Some components have already approved a budget for prizes in the various groups. The Committee on Dental Health Education and the state poster committee will decide on the state prizes within the next sixty days. It is, however, planned to give an attractive prize to the state winners. Whenever a contest is conducted in the school or towns, the prizes are left entirely with the local dental society, lay organizations or school officials. Some of the teachers in rural schools plan to give the winners in their school such prizes as special reading privileges, permission to attend matinees and other special favors which appeal to their children.

The work in this contest in the State of Illinois is progressing and the components are rapidly perfecting their organizations. Many of the teachers began their posters as soon as they were notified of the contest, but most of them began after the first of the year. Approximately 3,000 printed forms have been sent to school officials, county superintendents, city superintendents, city and county nurses, teachers and lay or civic organizations. The requests are coming in daily and we are looking forward to a great display of fine posters at the annual meeting of the Illinois State Dental Society, in Peoria, in May. The slogan adopted in Illinois is "Illinois First in the A.D.A. National Poster Contest."

Exhibit presented by the Dakota Dental Society and Woman's Auxiliary at the North Dakota State Educational Meeting, October 1937.

# DENTAL HEALTH EDUCATION PROGRAM IN THE PUBLIC SCHOOLS OF BELLEVILLE, ILL.

By JULIAN W. SMITH, D.D.S., Belleville, Ill.

THE Belleville Public Schools are now entering on their eighth year of full-time supervised dental health education. Our program is threefold in that we have inspection and education, and dispensary service for indigent children.

This supervision comprises nine schools, eight grade schools from kindergarten through the sixth grade and a junior high school of seventh and eighth grades.

In 1924, through the efforts of the Belleville Dental Society, the board of education established a thoroughly equipped dispensary in the junior high school building, in which each member of the dental society gave gratis an afternoon of service to the indigent children of the schools. This work was continued for five years, and although we had evidence of a vast amount of good accomplished, we were not attaining the goal for which we were always striving, preventive dentistry. This we knew could be attained only by the education of the child in the importance of a clean and healthful mouth.

This important phase was presented to the board of education, who readily saw the value to be received by Belleville school children. Therefore, in 1930, a full-time dental health education program was installed, with a full-time supervisor. This program has been functioning perfectly ever since.

The educational program consists of various types of dental health education material, selected to correlate, as nearly as possible, with the subjects in the curriculum. Each classroom, at the beginning of each semester, is given such material as the children in that room are capable of comprehending and absorbing. Some of this material is individual or seat work; some is used as a classroom project. To make this clearer, I will outline my program for this year. In the kindergarten, we are using the health soldiers poster in a classroom project; in the first grade, the Mickey Mouse project, consisting of honor roll, buttons and honor certificate; in the second grade, dental health leaflets; in the third grade, a puzzle project from the National Dairy Council; in the fourth grade, "Happy Days with Jack and Joan"; in the fifth grade, "Play and Exercise in Different Countries," with supplementary reading for the teacher on each poster; in the sixth grade, "Answer Your Own Dental Questions" wheel; in the junior high school, talks with lantern slides and movies. This work is supervised by classroom visits, giving talks in the way of stories in the lower grades, talks with lantern slides for upper grades and mouth health plays.

In addition to the school work, lectures are given to lay groups, such as the P.-T.A., civic clubs and women's clubs.

In our work in the dispensary last month, we worked for 157 children, and in this group we gave forty-four treatments and nineteen prophylaxes; placed forty-one alloy fillings, fourteen copper cement and fifteen synthetic cement, and made two deciduous extractions. We found twenty-seven children needing no service after examination. During the year 1936-1937, we gave service to 642 children.

The funds for this department are provided by the board of education, which also furnishes toothbrushes for all dispensary patients.

Last year, Charles F. Deatherage, chief of the Division of Dental Health Education, made a survey of the schools, and after statistics of the findings were compiled, it was found that we were far below the state average in cavities per child.

The economic evaluation of a dental health education program is of vast importance.

A pupil cannot appropriate the elements of an education while he is uncomfortable. Owing to the relief from dental suffering which the service in our dispensary has achieved in these last seven years, the number of repeaters was, without doubt, largely reduced.

A survey of Illinois public school children by E. H. Smith, of Libertyville, Ill., has shown that 29.25 per cent of repeating in the public schools of Illinois was from conditions directly attributable to dental disease. To allow for any margin of difference in the case of the Belleville schools, we estimate, conservatively, that 10 per cent of those receiving dental care in the dispensary would have been repeaters without this dental care.

With service given 642 children last year, 10 per cent of that number, or 64, would have been grade repeaters without this dental care, made possible by the board of education. The estimated cost of educating a pupil in our school system during the year of 1936-1937 was $74.13. On this basis, the total cost of reeducating these sixty-four pupils would have been $4,744.32. In other words, without the dental service in our schools, the board of education would have had an additional outlay of $4,744.32.

However, the benefits to be derived from a dental health education program cannot be measured in dollars and cents. We must think of it in terms of improvement of the dental health level of the school children and the elimination of dental disease as a factor in scholastic failure. These children will have a brighter and happier outlook on life, and as future citizens will help to make the community a happier and healthier place in which to live.

We believe that our dental health education program is a success and we attribute this success to the board of education, which is alert and cognizant of the need of dental health in school children, and to our teaching staff for its excellent cooperation.

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# FINDINGS IN SURVEYS* ON VINCENT'S INFECTION AND MOTTLED ENAMEL IN KANSAS

## VINCENT'S INFECTION

THE survey on Vincent's infection was made December 17, 1937, affording a cross-section of the school children in a typical first class city, Coffeyville. Five hundred and two white children, 7-8 grades, Roosevelt Junior High School, and 350 colored children, grades 1-12, Cleveland and Douglass Schools, were examined. The clinical evidence was checked by the examining dentists and rechecked by the director of the division of dental hygiene, who also made smears. The smears were stained and interpreted on the premises by the director of the public health laboratory. Only cases that gave definitely positive findings, both clinically and microscopically, were tabulated as positive. Smears were made of every mouth. The findings are: White children: negative, 59.3 per cent; indefinite, 32.5 per cent; positive microscopically, 17.1 per cent; positive microscopically

*Conducted by the Kansas State Board of Health, Division of Dental Hygiene; Leon R. Kramer, director.

and clinically, 8.67 per cent. Colored children: negative, 57.7 per cent; indefinite, 18.6 per cent; positive microscopically, 23.7 per cent; positive microscopically and clinically, 14 per cent.

The number of positive cases found in the colored children is almost identical to the findings of a survey made of 300 white children from families on direct relief in Marshall County, Kansas, made by this division in June 1937. Evidence gathered from the clinical plus microscopic findings in more than 1,400 mouths of preschool, school and adult groups, by the division of dental hygiene with the cooperation of the public health laboratory during the last six months, leaves little doubt that scorbutus of the gums, resulting from a diet that is deficient, especially in vitamin C, together with the subsequent Vincent's infection, is a major predisposing cause of pyorrhea alveolaris. It also pictures the magnitude of this heretofore neglected public health problem. Using the lowest percentage in our findings to predict the number of positive Vincent cases in the school children in the State of Kansas, this figure would be in excess of 50,000. Vincent's infection was made a reportable disease in 1932.

F. P. Helm, M.D., epidemiologist; Charles A. Hunter, Ph.D., director of the public health laboratory; Raymond B. Leach, bacteriologist, and Florence Gallant, school nurse, Coffeyville, cooperated and assisted in the survey.

### MOTTLED ENAMEL

A survey on mottled enamel was made, December 22, 1937, with special attention to cases of mottled enamel in Wallace County, grades 1-12. Wallace County is one of the more sparsely settled counties. It has no dentist. It is in the dust bowl area and is also in the area in which the drinking water has a high fluorine content. The comparable excellence of the children's teeth in this county adds another bit of evidence in support of the idea that although fluorine poisoned water causes mottling of the enamel, it also seems to make the normally formed teeth more resistant to decay. The findings are as follows: number examined, 540; without defects, 25 per cent; have received dental service, 50 per cent; have own toothbrush, 82 per cent; have malocclusion, 12 per cent; need teeth cleaned, 15 per cent; have diseased gums, 5 per cent; mouth breathers, 5 per cent; have abscessed teeth and/or decayed roots, 3 per cent; have mottled enamel, 8.8 per cent.

The number of cavities per child in the temporary teeth in grades 1-8 was 1+. The number per child in the permanent teeth, grades 1-12, was 0.9.

## SUGGESTIONS FOR RADIO SPEAKERS*

THE purpose of this pamphlet is to aid the members of the dental and allied professions in the preparation and delivery of radio talks to the lay public for the promotion of good mouth health and dental health service.

Education of the radio audience is not achieved unless the listener assimilates and is stimulated to act upon the advice given by the speaker. An effective mouth health broadcast should therefore be informative in content, simple in text and dignified in manner of presentation.

*Prepared [in pamphlet form] by the Oral Hygiene Committee of Greater New York.

### SUGGESTIONS

1. Plan your talk by first making a brief outline of the main topics to be considered. Arrange these topics in a logical and sequential manner.

2. Be sure to make the beginning of your talk attractive to the audience. Then work up the points discussed to an interesting conclu-

sion so as to hold the listener's attention to the end. Aim to make every word and sentence count in effectiveness.

3. Use English which is strictly grammatical. One does not have to be a literary expert in order to understand the fundamentals of correct usage.

4. Write sentences of moderate length, neither too short nor too long. It is best to use only one distinct thought or statement of fact in one sentence. Introducing too many thoughts or facts into one sentence weakens its assimilation by the listener.

5. In discussing scientific matters, use terms which can be easily understood by your audience. Try to avoid highly technical words and phrases. If you must resort to such technicalities, immediately clarify them in plain words. Remember that pedantic and academic discourses antagonize the lay audience.

6. Wherever possible avoid the use of the personal pronoun I. It is always preferable to use the pronoun we. Above all, remember that the radio is no place to air your personal likes and dislikes.

7. Always omit personal references to cases in your own practice in order to avoid any hint of self-exploitation, which is distasteful to the lay audience and to your professional colleagues. If using personal experiences, narrate them in an impersonal manner.

8. Speak commendingly of the best accomplishments of your profession and the allied professions. Avoid discussion of professional shortcomings and controversies. Speaking of such things to the public does not have any constructive value but on the contrary leaves a poor impression with the layman.

9. Always make it a point that the advice you offer is applicable to the average layman under ordinary conditions by the average dentist. Do not offer recommendations which leave a thought with your listeners that professional examination and treatment suggested is procurable only by people of means. In other words, avoid giving the impression that competent dental health service is a luxury.

10. Be sure your entire talk can be broadcast in the time allotment assigned you, without having to speak too rapidly in order to complete it. Do not overwrite.

11. Before giving your talk, rehearse it aloud by reciting every word of its contents just as you think it should be spoken over the radio. Points to rehearse especially are enunciation, raising and lowering of the voice, pauses, accents on important words and timing of the entire talk.

12. In speaking over the radio, talk to your audience in a sincere and friendly manner. Use a telephone tone of voice. Do not rustle the pages of your manuscript and remember that every extraneous sound you make goes over the air. Have each listener feel that he and she individually is the object of your earnest educational endeavors.

"Prevention Through Education"

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## DENTAL HEALTH FOR AMERICAN YOUTH IN NORTH DAKOTA

Believing that a dental public health campaign can be effective only by carrying the facts visually to the people themselves, wherever they may congregate in groups, the North Dakota State Dental Auxiliary cooperating with the state dental association, launched its campaign at the North Dakota state educational meeting in Minot this fall. The American Dental Association slogan "Dental Health for American Youth" was used to caption our visual exhibit. All visitors were invited to register and to check their preferences on the educational material displayed, thus giving us an expression regarding our teaching aids from the teacher angle.

This display was under the able direction of R. C. Lang of Minot, and state-wide reports since have indicated that it was well worth while. We are indebted for the material used to the American Dental Association Bureau of Public Relations; the Minnesota State Dental Auxiliary, and the Good Teeth Council of Chicago. We appreciate also the cooperation of the Director of the Bureau on this project.

Present plans in our educational campaign will reach our public through the avenues of radio; the facilities of our state department of education, whose cordial cooperation we are fortunate in having, and a permanent dental

health display which will be used at county fairs and meetings of various types, and at state conventions other than those of the dental profession.

The committee of the state dental public health program is working hard to formulate a workable and practical dental health program, which will be presented for approval at the state dental association meeting in May.

MRS. FERDINAND B. PEIK, *Chairman,*
Educational Activities.

## WANTED, OLD FORCEPS*

IF you have any old, or new, forceps that you would like to donate to the East African Mission Service, send them to the Rev. John D. Pointer, in care of the Board of Foreign Missions, 150 Fifth Avenue, New York City.

The Rev. Mr. Pointer, missionary of the Methodist Episcopal Church in the Limpopo District, Portuguese East Africa, has eighty-five native preachers on his staff. One of the several side lines of the missionary service is the pulling of the aching and decayed teeth of the African natives. Thousands of these people suffer from all kinds of tooth trouble, but they have no knowledge of dentistry. Unless given relief by the missionaries, they must resort to self-treatment, which usually consists of prying the offending teeth out with a nail or knocking them out with spikes and hammers.

The Rev. Mr. Pointer writes that he is badly in need of ten or a dozen pairs of forceps with which to equip his preacher assistants because their native charges are entreating their help.

*Publication requested by the Board of Foreign Missions of the Methodist Episcopal Church.

## THE A.D.A. APPOINTMENT BOOK—AN APOLOGY

WE wish to apologize to the several hundred members whom we were unable to supply with one of our new 1938 appointment books.

As this was a new and untried service, we had no way of estimating the number of books needed—and we underestimated. The complete edition was exhausted by December 20 and subsequent orders had to be returned, with our apology.

To judge from the large number of highly complimentary letters received, the new book has, in the vernacular, "clicked." A number of excellent suggestions have also been received which we intend to incorporate in the 1939 edition, making it even better.

Again we apologize for being unable to fill all orders and we urge all members to send in their 1939 orders early next fall so that all may be served.

# DENTAL ECONOMICS

## CONTINGENCIES

By Joseph R. Horn, D.D.S., New York City

In order to render successful treatment or to handle a dental problem successfully, preliminary steps should have been taken including the relationship established with the patient, the dental and medical history and an accurate and thorough diagnosis. However, this cycle is not complete without a definite understanding, on the part of the dentist and patient, of the responsibility involved should unfavorable reactions occur during the course of treatment, or after work has been completed. The patient should also have knowledge of such possible contingencies prior to the treatment.

The dentist must determine the degree of responsibility that is his in every dental operation, and he alone must decide whether he shall proceed with the treatment.

A patient might request the extraction of a number of teeth, and if it is the judgment of the dentist that these teeth are normal and should remain in the jaw, it is his duty to so inform the patient and, in the patient's interest, refuse to proceed with such treatment. There is the possibility that unfavorable contingencies might arise later, and the dentist could get into difficulties regarding the advisability of removing teeth that were normal. The final decision as to the proper procedure rests upon the dentist.

There are certain unfavorable contingencies that might occur after specific treatment. For instance, after the extraction of a tooth or after surgical procedures, there is the possibility of infection or severe hemorrhage, or swelling and acute pain. The patient may be entirely ignorant of the possibility of such reactions. It is the duty and responsibility of the dentist to prepare the patient for these after-effects.

There should be a certain amount of conservatism displayed. To simply state to the patient that during the extraction of a tooth there might be a fracture of the root or an accidental laceration, or that, following the extraction, there may be pain for a number of days or swelling accompanied by discoloration, is not wise. Tact and diplomacy should be used in outlining such contingencies.

The absence of any postoperative or posttreatment instructions indicates pure negligence on the part of the dentist. Through proper administration and proper guidance, the patient can be prepared to cope with any contingencies. In surgery or exodontia, it is absolutely essential to give postoperative instructions, not only verbally, but also in writing.

In operative dentistry, patients are less likely to be familiar with or aware of the conditions which may occur after the completion of certain work. For instance, after the insertion of an inlay or any other type of restoration, the unfavorable symptoms may include reaction to heat and cold over a long period of time. If the patient has not received instructions regarding the possibility of this reaction, and the necessity of reporting such symptoms, there is the possibility that the

tooth may become pulpless, or that an acute infection may set in. The patient may be inclined to neglect these reactions at first, taking for granted that they will pass away, and may thus do himself a great injustice.

However, if a patient takes it upon himself not to return even after he has received specific instructions, the responsibility falls upon him, and any unfavorable conditions that occur afterward are due to his negligence. The legal responsibility would culminate here as far as the dentist is concerned, but it is advisable to forward a letter to the patient advising him of his negligence and of the responsibility that he has assumed.

### WHAT IS A CONTINGENCY?

What are the contingencies that may arise during or after treatment of a case?

A contingency is something likely or liable, but not certain, to occur; that is, probable. The term "incidental contingencies" covers the possibility of happening, a contingent event, a casualty, any unpleasant or unfortunate occurrence that causes injury, loss, suffering or death.

Some of us have had experience with these contingencies, and we believe that they are a subject that requires intensive study and application through a gradual process in order to assure satisfactory results.

What would we call satisfactory results? 1. A proper relationship. 2. An enthusiastic patient. 3. An understanding as to why the dentist will render such and such services; namely, a fully informed patient.

We must recognize (1) with old patients, all temperamental and other circumstances, financial or personal and (2) with new patients, all temperamental and other circumstances.

Contingencies can be classified as (1) personal, (2) technical, (3) temperamental and (4) financial. Each is not independent of the others, but rather definitely dependent on them, and is related to our routine safeguards for the protection of patients.

During the process of the examination, we must include the routine safeguards, which are (1) a general health history; (2) a dental history; (3) a thorough examination; (4) an outline of all work indicated; (5) instructions to the patient as to coincidental and posttreatment contingencies; (6) posttreatment and postoperative instructions, and (7) posttreatment and postoperative supervision.

The possibility of unfavorable contingencies should be submitted to the patient before the execution of services (1) to secure complete cooperation of the patient in preventing such contingencies or in coping with them as they develop, and (2) should such unfavorable contingencies arise, to enable the patient to handle them and safeguard himself.

The presentation of technical contingencies should be made in simple language so that any patient can understand what the dentist is talking about.

They should be presented in verbal or written form:

1. Verbally at the chair by the dentist, the secretary writing down all notes so that she herself will understand what is indicated and will be able to instruct the patient when the time arrives.

2. Verbally by the secretary at another interview.

3. In writing by the secretary, to be called "Instruction Form" or to be typewritten under the heading "Instructions."

The word contingencies should not appear on paper, but we can write out in "Instruction Form" all contingencies involved.

On verbal presentation of technical contingencies at the chair, the dentist should carefully explain to the patient in simple terms that he desires his cooperation during the treatment of the case in order that it may terminate successfully. For instance, let us start with a tooth that has been partly destroyed owing to

advanced decay. After diagnosis has been made and it has been decided that the tooth may require root canal work or perhaps extraction, the decision should be explained to the patient so that he and the dentist may both be prepared for any contingencies that may arise because of the condition present.

The patient should, at the first visit, be instructed by the secretary to report by telephone any unfavorable reactions to the treatment of the tooth, and, if necessary, at this time, the secretary should outline in writing the reactions that might ensue, so that, if the tooth should be extracted, the patient will not be surprised.

On completion of any restoration, written instructions should be given the patient routinely.

Instructions can be classified under: 1. Operative dentistry. 2. Porcelain restorations. 3. Repair—vulcanite—rubber. 4. Emergency bridgework. 5. Emergency denture work. 6. Artificial denture work or artificial appliances. 7. Porcelain jacket crowns. 8. Root-canal therapy. 9. Orthodontia. 10. Periodontia. 11. Children's dentistry. 12. Exodontia and surgery.

The word "guarantee" has been used too often and has created a condition of distrust among patients. The word "permanent" has had its influence for many years and is having devastating effects now, not only on the public, but also on the profession. This word should be outlawed from our nomenclature. Patients are accustomed to hear the terms "temporary teeth and permanent teeth" and "temporary denture and permanent denture." Instead, we could say the first and second set of teeth or the first and second denture. There is misinterpretation on the part of our patients when they are told that we will construct an artificial bridge or denture which will be permanent. Should any contingency arise, such as the fracture or the destruction of a denture, for any one of a number of reasons, the implication is that they paid for something which was to be permanent and that no such accident should ever occur.

Contingencies do arise, and it is the responsibility of the dentist to safeguard not only himself, but the patient as well.

In operative dentistry, when teeth have been neglected over a long period, the patient is usually completely unaware of the presence of decay, because the tooth has never hurt. It is a condition like this that would lead the patient to question why the tooth broke down almost to exposure of the pulp, without any unfavorable reactions. The dentist should explain the condition as he finds it and show how the process can take place without pain, but should add that after the decay and the diseased part of the tooth are removed, certain reactions may arise.

It may be advisable that instructions be given in written form. This will allow the patient to be prepared for any contingency.

In operative dentistry, the instructions could be as follows: Owing to the advanced condition of decay, it is possible that the patient may experience an uncomfortable feeling or perhaps pain for some time after treatment of the tooth or after completion of the restoration.

In order to assure optimum results, the patients should: (1) report any unfavorable reactions to heat or cold, (2) report any dull or sharp pains on chewing and (3) not chew sticky substances, such as caramels or taffy.

### SYNTHETIC PORCELAIN

One of the troublesome restorations in dentistry is that employing the porcelain or synthetic filling. Many years ago, the type of filling recommended to the patient and completed was the gold foil. To this day, we still see, in many of our older patients, the class III hammered gold foil filling. With the change of times, and the emphasis on esthetics, the dentist as well as the patient dis-

couraged the use of gold foil in the anterior teeth and instead prescribed the porcelain or synthetic filling. The request for this type of restoration by the public is based on the appearance of the front teeth and the objection to having any gold showing anteriorly.

Although one type of restoration is superior and more lasting than the other, the temperament of the patient must be taken into consideration. If the vanity and the happiness of the patient is to be considered, the doctor must cooperate; but the patient should be told that this type of filling is but a synthetic one and that it will not last more than two or three years. This advice should be given to the patient prior to execution of the work. After completion of the restoration, it may be best that the patient be given the following information, in writing:

PORCELAIN FILLINGS

Synthetic porcelain undergoes a chemical reaction through the presence of saliva in the mouth. By this action, the porcelain is gradually discolored and dissolved. This usually occurs within a period of approximately two years. It is often necessary, therefore, to replace a new filling at the end of that period.

*Instructions.*—1. Do not chew on this tooth for twenty-four hours.

2. Do not drink any hot liquids for twenty-four hours.

3. Report any unfavorable symptoms immediately.

REPAIR OF A DENTURE

One of the simplest services in dentistry is the repair of a denture, and yet it may give rise to trouble or even to loss of a patient. The repair may be on a vulcanite full or partial denture or on a full or partial "luxene" or any other base. It may also be a repair of a fracture or the replacing of a missing tooth on a denture.

It is poor policy to accept a case of this type, on delivery, from some one besides the patient, with a request for repair of the denture. It is a good rule to have the patient come in as it may be necessary to take an impression. In some cases, on receipt of a repaired denture, the patient has claimed that whereas formerly the denture was comfortable and tight fitting, it is now ill fitting and uncomfortable, and has insisted on having a new denture.

This can be avoided by observing the following rule:

The patient should be asked to come to the office for observation of the denture in the mouth. If the examination discloses that the denture is loose fitting, the doctor should so inform the patient and, before the latter leaves, put this diagnosis in writing:

The examination of your broken denture (plate) showed it to be fractured and——— missing. Upon further examination, the denture was found to be loose fitting in the mouth.

The chemical reactions which an old denture undergoes in replacing new material at the fracture line, or in replacing a tooth, as in revulcanization, may result in a warpage which cannot be controlled. The denture may also discolor.

The repair is an emergency measure only.

EMERGENCY BRIDGE OR DENTURE

In construction of emergency bridgework or emergency dentures, the word "emergency" is preferable to "temporary" as it really means that it has been constructed to serve for a short time only. Use of the word "temporary" misleads the patient as to the work that is to follow (the permanent bridgework). As stated previously, nothing is permanent.

INSTRUCTIONS REGARDING EMERGENCY BRIDGE AND EMERGENCY DENTURE

An emergency denture functions temporarily and mainly for the sake of the esthetic appearance. The tissues beneath will shrink until resorption of the bone has taken place, causing a loosening of this denture.

It will take a while for the tissues of the mouth and the muscle attachments to adapt themselves to this new function.

The patient is given the following instructions:

1. Do not bite on hard substances.
2. Be careful in cleaning the bridge or denture; if it drops, it will break.
3. If there is any pain, remove the denture and replace after a few hours' rest.
4. Return regularly for further instruction and correction of this emergency bridge (or denture).
5. A second denture or bridge will be constructed when the tissues are ready.
6. Do not hesitate to call for further instruction.

### PARTIAL DENTURES

The success of the denture depends on the condition of the tissues supporting the denture and the remaining teeth. Therefore, the patient must return at least every two months, after the work is completed, for prophylactic care of the remaining teeth and observation of the tissues.

The following instructions are given:

1. The remaining teeth should be cleaned daily.
2. A special brush should be used for cleansing the denture.
3. Care should be taken when cleaning the denture. If it drops, it will break.
4. If there is any pain and the tissues hurt, remove the denture.
5. Do not hesitate to call for further instructions.
6. You will be recalled for observation within two months.

### ARTIFICIAL DENTURES

Routine bridgework and prosthetics is one of the most troublesome fields because it deals chiefly with construction of artificial appliances, and many contingencies arise after the replacements are completed. The patient must be instructed prior to the execution of the work or during the preparation of the field for the artificial appliance.

Before the work is completed, the patient should receive written instructions.

In replacing the missing teeth by artificial dentures, the fullest cooperation and perseverance of the patient is necessary. It may take a while for the tissues of the mouth and the muscle attachments to adapt themselves. The patient will, with tolerance, learn, while under our supervision, the proper cutting and chewing of food, and all other functions of the artificial denture. Routine observation and adjustments of the dentures will be necessary. The patient will be required to visit the office, when so intructed, after completion of the work.

The patient is advised to carry out the following instructions regarding these artificial appliances.

1. Do not bite on hard substances.
2. Be careful in cleaning the denture; if it drops, it will break.
3. If there is any pain and the tissues hurt remove the denture and replace after a few hours' rest.
4. You must return for correction of the denture.
5. Do not hesitate to call for further instructions.

### CERAMICS

Ceramics in dentistry plays an important rôle in restorative dentistry. The porcelain inlay and the porcelain jacket crown have taken their rightful places in obtaining esthetic physiologic results.

The outstanding claim for porcelain jacket crown work is that it affords a beautiful anatomic reproduction of the tooth.

The following instructions are given the patient regarding porcelain inlays and porcelain jacket crowns:

1. This type of restoration is made mainly for the esthetic appearance.
2. Do not chew hard substances on this tooth as it may fracture.
3. Return, when instructed, for correction of the bite in the area of the porcelain crown.
4. Negligence will cause fracture of the crown.

Instructions on root-canal therapy are as follows:

The clinical and X-ray examinations disclose the following:

The————tooth is extensively decayed. Owing to this neglected condition, there is a possibility that the tooth may have to be extracted.

An attempt will be made to retain this tooth by devitalizing it (removing the nerve content and filling the canal). This is called root-canal therapy.

After completion of the root-canal work, should there be any unfavorable reactions, such as pain or swelling, the tooth will be extracted.

1. The patient is to report any unfavorable reactions within the next twenty-four hours.
2. The patient must report at least every three months for observation and x-ray examination to ascertain the condition of the root and the surrounding area.

PERIODONTIA

The field of periodontia is still in its early stages of development. Many problems as to diagnosis and treatment have not yet been solved. The patient's knowledge of gum conditions is very limited. The public at large has heard the terms "trench mouth" and "pyorrhea."

The responsibility in treating advanced conditions of periodontoclasia is great, and therefore all possible contingencies must be explained and outlined to the patient in definite, concise language. Especially in this field, the complete cooperation of the patient is required because the home care is just as important as the office treatments. Very often, patients are disappointed in the results of the treatment of their gum condition, and this would mean not only the loss of the patient but also his embitterment.

In this type of service, it must be noted that even after months of treatment and an attempt on the part of the dentist to eliminate the condition, there still may be a loss of a number of teeth.

The cooperation and obedience of the patient are necessary for the success of the above-prescribed treatment.

In order to prevent or check further loss of tissues and bone structure surrounding the teeth, and to lessen the danger of further loss of remaining teeth, the patient should follow the prescribed method of tooth brushing and gum massage and present himself or herself for gum treatment at specified intervals. It is the patient's responsibility to follow all instructions as to home care, for the improvement of the condition of the gum tissues.

In view of the advanced condition, it is possible that the patient may lose a number of teeth.

EXODONTIA AND SURGERY

There is great responsibility in the field of oral surgery, and the surgical technic is not the only important factor. Many other considerations have a bearing on the case. The technical side of the actual performance is just as important as the results that follow. After the diagnosis and the findings, which lead to exodontia or surgical measures, the patient must be made aware of certain contingencies that might arise during the work or after the surgical procedure is completed. Supervision of the postoperative condition and symptoms must be under control by the doctor and his assistant. Therefore, before proceeding, it might be proper to explain to the patient the findings and what may occur during the operation. Conservative, simple language should be used in order not to instil fear or apprehension in the patient.

For example, a patient visits the office with a broken down lower right third molar. After the diagnosis is completed, the patient should be instructed as to the condition of the molar and the possibility of fracture of roots and the contingencies that may arise after removal of the tooth. Let us assume that the examination discloses a broken down lower right third molar with curved apices. There is always the possibility of fracture of the apices and the necessity for extensive operation. Since, in the patient's mind, this may appear as a simple extraction,

the dentist should explain, by means of roentgenograms, the anatomic position of the roots and the possibility of removing the roots in several pieces. The word "fracture" should not be used, as this may instil fear.

After completion of the operation, the patient should receive verbal as well as written instructions. This is postoperative supervision.

Instructions are as follows:

After removal of the teeth and treatment of the infected area, there may be excessive bleeding and some temporary pain and swelling due to the long-neglected condition. Therefore, it is imperative for the patient to report any unusual symptoms, such as excessive bleeding and swelling of this area, and he must report for postoperative treatment and observation.

Attached is a prescription which should be followed carefully.

Apply icebag externally 15 minutes to the hour.

Mouth wash of————every hour.

℞ Sedatives: 1 tablet at———
1 tablet at———

EXODONTIA AND SURGERY

If hemorrhage occurs, apply thromboplastin on a sterile gauze pad to the area of operation and bite on it with pressure for one hour. If this does not stop the bleeding, call this office immediately.

Telephone_____Reg. No.
Name _____
Address _____
City _____

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Name _____Age _____
Address _____Date _____

(Other side of prescription)

Instructions to patient:

1. Do not touch the socket where the tooth has been extracted.
2. Do not disturb the blood clot which forms.
3. If there is excessive bleeding, place a large piece of sterile gauze over bleeding area and bite. If bleeding continues, call the office.

CHILDREN'S DENTISTRY

It is best to instruct and educate the parent or guardian as well as help the child to understand what is to be done. It is helpful if, at the first examination of the child, the parent or guardian is invited to stand at the side of the chair and be informed of the clinical findings. If the child is fearful, it is a good rule not to proceed with any work at that time unless it is a question of alleviating pain. It is better to have the child return another time when he has more confidence and when other children are present.

To have the child patient observe the dentist at work on other children of the same age is very helpful. The parent's education along these lines is just as important, and some time should be devoted in explaining the importance of cooperation on their part at home. The parent should never ask the child "Are you afraid?" or "Did the doctor hurt you?"

Written instructions are given as follows:

The greatest changes in the body and in the jawbones take place in the early years of life, especially between the ages of 2 to 12. The expression of the face, the muscle development of the jaws and the second set of teeth which erupt in the near future are affected definitely by the first set of teeth. Therefore, during this period, the child should be brought into the office every three months for observation and examination. This enables us to determine the eruption and position of the first set, or baby teeth, and the second set of teeth, which follow.

When dealing with an unusual case, in which an accident has occurred to the teeth, certain other precautions are necessary. For example, in a child, aged 9 years, a blow to an upper anterior tooth caused the right and left central incisors to be fractured at the incisal edge. Here, the parent should be advised of the contingencies which may arise in this case, because it is important that the parent know that there is a possibility of loss of these teeth.

# COUNCIL ON DENTAL THERAPEUTICS

## DR. GORDON RESIGNS

Dr. Samuel M. Gordon, Secretary of the Council on Dental Therapeutics from its inception, has resigned to take a position with a pharmaceutical firm in the East. The staff in the Central Office of the American Dental Association join in wishing Dr. Gordon the greatest measure of success in his new field of effort.

# ACCEPTED DENTAL REMEDIES

The following articles have been accepted as conforming to the rules of the Council on Dental Therapeutics of the American Dental Association. The Council wishes dentists to understand that the admission of an article does not imply a recommendation. A copy of the rules that govern the Council in the consideration of articles will be sent on request.

COUNCIL ON DENTAL THERAPEUTICS.

## DENTIFRICES*

***The Fair Tooth Paste:*** Composition: See Sheffield Tooth Paste (A.D.R. 1937, p. 110.)

Manufactured by the Sheffield Company, New London, Conn. Distributed by The Fair, Chicago, Ill.

## PEROXIDES AND PER ACIDS†

***Sodium Perborate-Merck***—A brand of sodium perborate, U.S.P.

Manufactured by Merck & Co., Inc., Rahway, N. J. No U. S. patent or trademark.

**Pilocarpine Hydrochloride, N.F.** (See A.D.R. 1937, p. 182).

***Pilocarpine Hydrochloride-Merck:*** A brand of pilocarpine hydrochloride, N.F.

Manufactured by Merck & Co., Inc., Rahway, N. J. No U. S. patent or trademark.

**Pilocarpine Nitrate, U.S.P.** (See A.D.R. 1937, p. 182.)

***Pilocarpine Nitrate-Merck:*** A brand of pilocarpine nitrate, U.S.P.

Manufactured by Merck & Co., Inc., Rahway, N. J. No U. S. patent or trademark.

## ANESTHETICS—LOCAL‡

***Procaine Solution (2%) with Epinephrine 1:25,000—"Oryl" Brand:*** Each cubic centimeter is stated to contain procaine hydrochloride, 0.02 gm., epinephrine, 0.00004 gm., sodium chloride, 0.005 gm., calcium chloride, 0.004 gm., potassium chloride, 0.0002 gm., sodium bisulfite, 0.002 gm., and distilled water.

Manufactured by Dental Products Company, Chicago, Ill. No U. S. patent or trademark.

*Procaine Solution (2%) with Epinephrine 1:25,000 in "Oryl" Cartridges, approximately 2.5 cc.*

*A.D.R. 1937, p. 105.

†A.D.R. 1937, p. 166.

‡A.D.R. 1937, p. 36.

***Procaine Solution (2%) with Epinephrine 1:50,000—"Oryl" Brand:*** Each cubic centimeter is stated to contain procaine hydrochloride, 0.02 gm., epinephrine, 0.00002 gm., sodium chloride, 0.005 gm., calcium chloride, 0.0004 gm., potassium chloride, 0.0002 gm., sodium bisulfite, 0.002 gm., and distilled water.

Manufactured by Dental Products Company, Chicago, Ill. No U. S. patent or trademark.

*Procaine Solution (2%) with Epinephrine 1:50,000 in "Oryl" Cartridges, approximately 2.5 cc.*

***Procaine Solution (2%) with Epinephrine 1:75,000—"Oryl" Brand:*** Each cubic centimeter is stated to contain procaine hydrochloride, 0.02 gm., epinephrine, 0.000013 gm., sodium chloride, 0.005 gm., calcium chloride, 0.0004 gm., potassium chloride, 0.0002 gm., sodium bisulfite, 0.002 gm., and distilled water.

Manufactured by Dental Products Company, Chicago, Ill. No U. S. patent or trademark.

*Procaine Solution (2%) with Epinephrine 1:75,000 in "Oryl" Cartridges, approximately 2.5 cc.*

# PRACTICE IN PARAGRAPHS

*This department is intended for busy readers. It aims to tell a vivid story in a few words. Items should be of a practical character, and free from padding—not more than a paragraph or two. We exact no limit, but two hundred words can tell most of these stories. Send in your ideas; they will be welcome.*

**Sinus Opening**—To the general practitioner: A sinus opening will close by granulation if treated properly and not overtreated; so why send the patient to a rhinologist?—*A. M. Stinson, Stewartstown, Pa.*

**Exodontia — Testing Fixation**—The tooth should be manipulated carefully with elevator or forceps. Resistance, not your strength, should be gaged. The grip should not be tightened suddenly, but power should be applied gradually. Caution is the watchword!—*John V. Hackett, Chicago, Ill.*

**Restoring the Abrasive Quality of the Mortar and Pestle**—When mortar and pestle for mixing amalgam becomes too smooth for proper amalgamation, place a little carborundum powder (silicon carbide) mixed with glycerine in the bottom of the mortar. Then, using the pestle, rub the carborundum with quite a little pressure. This will etch both the mortar and pestle and thereby remove that smooth finish which makes amalgamation difficult.—*D. L. Harris, Minneapolis, Minn.*

**Carving an Alloy Filling**—To start carving a compound alloy filling after removing the matrix, use a small spoon excavator before using the Frahm carvers. There will be no flaking of the alloy, and we can thus start a cleanly defined marginal ridge, and so pave the way for the other carvers and burnishers. —*M. M. Foster, Brooklyn, N. Y.*

**Skin Care**—Harsh, red skin on the hands of the dentist is repulsive to the patient. A solution of one part witch hazel, one part water and a little less than one part glycerin is useful for keeping the hands in good condition. This solution is kept on the wash basin in a small bottle, with a medicine dropper. After every

washing of the hands, some of this solution is poured into the palms and rubbed gently into the hands, which need not be very thoroughly dried before using this application. If you wish, ethyl alcohol may be substituted for the water in the solution, thus making it antiseptic.—*Louis Wack, Bronx, N. Y.*

**Inlay Casting**—Just another step in the investment of an inlay which seems to get more accurate results when added to the method you now use: First, coat the wax with a layer of investment batter about 0.5 mm. thick and allow it to set one or two minutes. Use an investment from which the sulfides have been removed. Now add the usual "sponge" investment, at least one-eighth inch thick, and finish with a shrinking investment in an asbestos-lined ring. Try this method and you will be convinced of its merit. Open the case and you will be interested to note that the gold has been cast against smooth hard walls as the inner lining has been baked to a brick-like hardness.—*W. Clyde Davis, Lincoln, Nebr.*

**Acres of Diamonds (Conwell)**—The uneasiness of the present age has resulted in dissatisfaction with filling materials. One too frequently searches for remote places, tripping, stumbling and even falling over the best in vain search for something not so good. Where indicated, gold foil is the most dependable and permanent filling material, the luster of which the march of time has brightened rather than dimmed. The prodigal son of the filling material is not only returning, but has arrived to stay, and dentists who fail through prejudice or otherwise to welcome its return are ignoring this most durable of filling material available. Since simple accessible cavities exist far in excess of one's fondest ambitions, it seems inopportune to attempt those more difficult. Such simple, easy cavities and patients of the most favorable temperaments form a combination patiently waiting for ambitious dentists to suggest and adapt this honest, permanent material.—*Herbert Ely Williams, Red Bank, N. J.*

**Pulp Death Following Capping**—By far the largest percentage of pulps lost after pulp capping die from toxemia and not from bacteria as many dentists believe. The bacteria which play their part in tooth decay are obligate aerobic and when robbed of contact with the oxygen of the air and oral fluids, as under a tight filling, are inhibited from further growth and soon die. In case they are not completely shut off from oxygen, their excreta and secretions soon create an acidity which destroys the bacteria. Softened dentin below large fillings frequently is found to be sterile and of a pH of 3 to 5. But the pulps continue to die from toxemia. This may be prevented largely by the following treatment: With the cavity made dry, apply on a pellet of cotton or spunk the following, mixed fresh each time: hydrogen peroxide, 10 drops; household ammonia, 4 drops. After a minute or two, remove and again dry. Then apply in the same manner the clear ammonia and follow with thorough bathing with warm water. This should remove all substances detrimental to pulp health. This treatment may be followed by any of the many methods of pulp protection. Of note is the Howe silver treatment, also the zinc oxide and eugenol paste.—*W. Clyde Davis, Lincoln, Nebr.*

**Root-Canal Therapy**—Why are some members of the dental profession so afraid to practice pulp-canal therapy and surgery that they continue to drive the public from them by saying that such operations are no longer practiced? The operations and treatment are very simple as compared with hundreds of procedures which are common in the practice of medicine and surgery, wherein the technic is many times more difficult. Note the management of the lesions of the eye, the ear and the sinus, to say nothing of the myriad of abdominal conditions attacked

and mastered. The medical men have lost confidence in the dentist because he has lost confidence in himself. The dental colleges of America have not quit the field. Nearly all are giving comprehensive instructions in harmony with medical practice in handling similar lesions. Nearly all have definite requirements for graduation, several as high as twenty to twenty-one root-canal cases per student. It is high time that all dentists familiarize themselves with these modern methods. The recent graduates are thoroughly drilled on the treatment and operations, and are proving hard competitors for the faint hearts and disbelievers, many times referred to as the "100 percenters." Before nursing your scepticism into positive negation, better write the clinical department of the school of which you are an alumnus and learn of today's teaching.—*W. Clyde Davis, Lincoln, Nebr.*

**Impression Materials** — Agar jelly makes a fine hydrocolloid impression material if it is modified. Five grams of dry agar flakes will absorb about 45 gm. of water. There will be no surplus that can be poured off unless the mass is squeezed. This will almost fill the average mixing syringe of 60 cc. capacity. Sodium or potassium sulfate, about 1 gm. to a syringeful will produce a compound against which plaster will set with a hard surface. This is because of the accelerating effect soluble sulfates have on plaster setting. Too much washing of the finished impression will dissolve out the sulfates and a cast poured will then have a soft surface. Sodium benzoate, about 1 gm., will act as a preservative. Too much rinsing will wash this out too. About 2 gm. of calcium carbonate, ordinary laboratory whiting, will make the mass white and give it a little more body. The strength and setting temperature are greatly influenced by the water content. Too much water will produce a weak jelly, and one that will have to be chilled greatly in order to be hardened. For this reason, the mixing syringe should be water tight, else water from the boiler will dilute the mass. A gasket, cut from old x-ray films, can be used in the end cap of the syringe, and the plunger end should be kept above water. Old pieces of jelly can be either dried or soaked until they contain just enough water to make them the proper hardness. Note the tremendous volume changes and warping that occur on drying. Small amounts of hard paraffin wax, about 5 gm., can be added and will slightly improve the working qualities. The wax will separate, however, unless the compound is continually mixed all through the cooling range until it just begins to set. This fact makes it impossible to use wax if the compound is intended for use in a duplicating flask. Impressions taken with this compound or proprietary brands should be poured immediately. If the jelly should happen to contain too little water, and the impression is allowed to soak too long, it will swell up and bulge out of the tray across the palate. One the other hand, even in an atmosphere of 100 per cent humidity, it will shrink considerably on standing. While the prices of proprietary brands are so high in comparison with the cost of the ingredients contained, it certainly is economical to make the hydrocolloid impression material in the office. Most important is the fact that the knowledge and experience gained in compounding and experimenting will make for more intelligent handling of the material, home-made or bought.—*Alfred T. King, 55 E. Washington St., Chicago, Ill.*

# CURRENT LITERATURE

## Fad of Alkalinization and Its Relation to Renal Lithiasis

By W. Ezickson

Alkalizing the system has become a fad, a treatment for everything, more often used than needed by the public. Clinical symptoms of alkalosis vary from the mild symptoms of anorexia, fatigue, vague pains and polydipsia to the severe syndrome of nausea and vomiting, headache, dizziness, mental confusion and convulsions. Many patients with alkalosis have been treated for acidosis. Alkalinizing as a treatment for dental caries should be carried out cautiously by practitioners. Studies at Pennsylvania Hospital show that renal calculi may be associated with hyperalkalinization.—*Pennsylvania M. J.*, 41:94, November 1937.

Martin Deakins.

## Lymphatic Leukaemia

By J. C. Banerjea

A survey of clinical manifestations of lymphatic leukemia in childhood demonstrates a disease of acute and short duration, the symptoms being pallor, anemia with fever, and definite blood changes with some enlargement of lymph nodes and spleen. Hemorrhages are noted in various mucous surfaces, especially of the gums. Ulcerative stomatitis in this condition is not uncommon. Considerable difficulty is experienced in the differential diagnosis with scurvy, thrombocytopenic purpura hemorrhagica, tuberculous lymphadenitis, Hodgkin's disease, lymphadenitis of congenital syphilis, infectious mononucleosis and lymphosarcoma.—*Indian J. Pediat.*, 3:193, October 1936.

B. J. Frey.

## Dietary Calcium and pH of the Lower Intestine

By E. C. Robertson

Rats fed calcium-poor diets were found to show marked stasis and dilatation in the large intestines; whereas those fed calcium rich diets did not show this. The pH readings in the stomach, duodenum and jejunum were practically the same regardless of the diet. In the low calcium group, the pH was near 6. The controls fed the corresponding adequate diet averaged a pH of 7. By means of a Petroff-Hausser bacterial counter, counts were made of the bacteria in the cecums of rats fed the adequate and the mineral-deficient diets. It was consistently found that there were many more organisms in the rats on deficiency diets. By Kjeldahl determinations, it was discovered that a higher protein level persisted. The higher protein might favor bacterial growth. This study is particularly interesting in the light of known common deficiencies in calcium intake.—*Proc. Soc. Exper. Biol. & Med.*, 37:140, October 1937.

Virgil D. Cheyne.

## Relation of Ascorbic Acid Ingestion to Mineral Metabolism in Children

By A. L. Daniels and G. J. Everson

Well-controlled experiments on preschool children show that no relationship exists between vitamin C (ascorbic acid) ingestion, within physiologic limits, and the retention by the body of calcium, phosphorus and magnesium. Although there may be a relation between vitamin C, calcium metabolism and caries in guinea-pigs, in man such a relation has not been established. Retention of nitrogen is increased, however, when the amount of orange juice is increased from 60 to 120 cc. The author believes that this retention explains the stimulating effects of vitamin C on growth. It suggests, in the light of work by others, that scurvy is primarily a disturbance of nitrogen metabolism resulting in tissue changes which prevent retention of minerals.—*J. Nutrition*, 14:317, September 1937.

Martin Deakins.

## Relation of Avitaminosis to Oral Pathology

By P. R. Howe

Evidence has been disclosed to indicate that dental disasters of today are largely due to deficiencies of minerals and of vitamins in the body. There is some evidence in the studies of the vitamins to support the diffrac-

tion studies, in that unsuspected changes occur in the organic substances of teeth and bones in such a condition as rickets. The same pathologic responses to deficiencies in A, C or D and the same recovery therefrom when the deficient animal is furnished with the missing factor are seen in the teeth as elsewhere. It is the hope of present-day research workers that medical men will work to build good teeth by advising proper nutrition in prenatal and early postnatal periods, as far as this is understood, and that dentists will regard dental disturbances as not isolated phenomena, but a result of the general physiologic condition—*New England J. Med.*, 215:1163, December 17, 1936; Abstr. *Am. J. Dis. Child.*, 54:1090, 1937.

FRANK ALLEN.

## Vitamin C and the Formation of Intercellular Material

By S. B. WOLBACH

VITAMIN C (cevitamic acid) is necessary for the formation of all intercellular substances having collagen as their basis. Its absence, therefore, prevents the formation of the matrices of white fibrous tissues, bone, cartilage and dentin. The consequences of its absence are most apparent in growing animals and in the repair of lesions of these tissues. The deficiency does not prevent the multiplication of the cells of each type of tissue, but the cells assume a common morphologic character, approximately that of embryonic connective tissue, and the histologic appearance indicates that a liquid material is produced in lieu of normal matrix. Because cell division continues in absolute vitamin C deficiency and therefore the synthesis of proteins, the speculations of a morphologist are along the lines of attributing to cevitamic acid a late rôle in the formation of collagen.—*New England J. Med.*, 215:1158, December 17, 1936; Abstr. *Am. J. Dis. Child.*, 54:1089, 1937.

FRANK ALLEN.

## Bone Regeneration Following Maggot Therapy in Compound Fractures

By H. T. SIMON, A. S. HAMILTON and C. L. FARRINGTON

THAT the beneficial action of maggots in infected wounds has long been recognized is shown by the comments of Ambroïse Paré and Larrey. Baer's observation during the World War aroused a new interest in this type of treatment. The author gives a detailed description of his latest technic for preparing the wound and applying the maggots to the wound. As a result of the action of the maggots, several changes in the wound are noted. In contaminated but not infected lacerations, no pus or, at most, little pus is noted, and fine, clean pink granulations appear, especially in the recesses where accumulations of exudate generally are seen. All bone fragments are loosened by the maggots and are easily removed during the routine dressings.—*J. Bone & Joint Surg.*, 19:985, October 1937.

J. FRANK HALL.

## Problem of Unilateral Harelip Repair

By FORREST YOUNG

THE author states that an operation in the repair of harelip should result in a normal contour. The features should be in correct proportion and position and, above all, symmetrical. An asymmetry of the face is more noticeable than a scar. The author considers harelip as presenting three distinct deformities: (1) the separation of the maxilla and the projection of the premaxilla in its various stages of deformity in conjunction with the notching of the lip; (2) the cleft in the lip, which should be carefully considered in the repair as to symmetrical vertical height of the lip on the two sides, as well as the distance from ala to mouth line, etc; (3) the deformity of the nose, the most important of the three. The nose is often shifted to the side opposite the cleft. The columella may lie in an oblique line and the opening of the nostril be drawn out into a narrow slit. The technic of Rose, Thompson and Mirault are briefly described and comments included. The author's operative technic is also described. Many cases with illustrations are used to show the final results.—*Surg. Gynec. & Obst.*, 65:348, September 1937.

J. FRANK HALL.

## Repair of Traumatic Fistulas of Stenson's Duct

By HAROLD GLASCOCK and HAROLD GLASCOCK, JR.

THE method consists of passing a metal probe from the buccal opening through the duct and out at the open wound, if the duct is severed about the middle. The middle of

a long thread is tied to the end of the probe and the probe is pulled back through the opening of the duct. The probe is released and an extra-coarse silkworm gut is then bent and hooked into the loop of the thread. The thread is then pulled back through the distal end of the duct at the wound, leaving the silkworm gut in the anterior half of the duct. The patient is given lemon juice to stimulate the flow of saliva in order to locate the opening of the distal portion of the duct at the wound. The probe is inserted in the duct and passed back into the parotid gland. Pressure is placed on the probe until the distal end is located at the angle of the jaw. An incision is made at this point and the probe pulled through, bringing the distal end of the silkworm gut with it. This draws the silkworm gut completely through Stenson's duct and the parotid gland. To hold the silkworm gut in place, a shot is applied at either end. The wound in the face is sutured. The silkworm gut is left in place for a period of from four to six weeks.—*Surg. Gynec. & Obst.*, 65:355, September 1937.

J. Frank Hall.

### Perversion of Taste Sensation

*To the Editor:* I have a patient who has been complaining for the past three years of a peculiar taste in his mouth. His tongue is always heavily coated, and he reports that he can feel pus exuding from one side of his cheek. All tests are essentially negative. Is it possible to have a suppurative discharge from the salivary or parotid glands without any swelling or other clinical evidence?

M. D., New York.

Answer. Two possibilities deserve exploration. Cultures should be made in brain broth from saliva taken aseptically through a cannula inserted into the parotid duct on the suspected side in order to rule out definitely infection of a low grade without obvious symptoms. The teeth should be examined for large metallic restorations. If two or more different metals are found, especially if a tooth under such circumstances is found bearing a large metallic filling adjacent or near to the origin of the perverted sensation, this clue should be followed up. Otherwise, this must be classified as a poorly defined neurosis characteristic of a patient in the decades of life.—Queries and Minor Notes, *J.A.M.A.* 109:813, September 4, 1937.

### Epulis Granulomatosis

By S. Ayres, Jr., and N. P. Anderson

The authors cite this condition as in the "no man's land" between the domains of the dermatologist and the dentist, the mouth, and as one not recognized by specialists in either field or by the surgeon. A case in a 52-year-old man is reported. A growth in the center of the lower gum, covering the gum and extending for approximately 2 or 3 cm., was hard, firm, irregular, fungating, pinkish, firmly attached and ulcerated in places. It had been noticed three days previously by a dentist after extraction of five "infected, gold-capped front teeth." All other teeth had been removed years before. Biopsy was made and examination revealed essentially a chronic granulomatous lesion with plasma cells predominating. The Kline test was negative. The lesion was treated with the roentgen-rays and 2 per cent aqueous solution of gentian violet topically. Potassium iodide was administered orally on the possibility that a yeast might be responsible for the lesion. After four months, only a slight roughness remained. The condition should be differentiated from tumors by biopsy. Eradication of oral sepsis is an important part of the treatment. Surgery has been used successfully, as well as irradiation. —*Arch Derm. & Syph.*, 36:1149, December 1937.

Hamilton Robinson.

### Changes in Teeth Following Parathyroidectomy. I. The Effects of Different Periods of Survival, Fasting and Repeated Pregnancies and Lactations on the Incisor of the Rat

By Isaac Schour, S. B. Chandler and W. R. Tweedy

The incisors of rats were used to study changes following parathyroidectomy because they reflect fluctuations in calcium and phosphorus metabolism. One hundred parathyroidectomized, albino rats were divided into 4 groups: 1. Those of short postoperative survival (three-twenty days), eighteen animals. 2. Those of longer survival period and treated before death with parathyroid extract or vitamin D preparation, fifty-seven animals. 3. Those fasting on every seventh day, fourteen. 4. Those of long survival (three months to one year) and subjected to repeated pregnancy and lactation, eleven. Control litter mates were used with unilateral parathyroid-

ectomy, with a sham operation, and treated with extract and vitamin D. Histologic controls from the same colony were also available from previous studies. Grossly unpigmented spots of opaque appearance, elongation of the teeth and a fine ringlike striation over the surface of the teeth were seen in Groups 2, 3 and 4. The growth rate of the incisors was within normal range. Roentgenographic examination revealed disturbances in the groups of longer survival. The calcification pattern of the dentin was studied histologically and compared with that of the normal rate in which rhythmic apposition and calcification at the rate of 16 micra per twenty-four hours has been observed. In Group 1, there was a denser calcification; in animals of longer survival, a defective formation and calcification of enamel and dentin. Fasting on every seventh day aggravated these changes, and in those animals subjected to repeated pregnancy and lactation, the disturbances were most severe. A ring of dentin laid down at the time of operation, separating the preoperative and postoperative dentin, appears to result from the shock to calcium metabolism and is named the calciotraumatic ring.—*Am. J. Path.*, 13:945, November 1937.

HAMILTON ROBINSON.

## Changes in Teeth Following Parathyroidectomy. II. Effect of Parathyroid Extract and Calciferol on the Incisor of the Rat

By ISAAC SCHOUR, W. R. TWEEDY, S. B. CHANDLER and M. B. ENGEL

FIFTY-NINE parathyroidectomized rats were treated with injections of parathyroid extract (twenty-nine animals) or with calciferol, vitamin D preparation (thirty animals). Therapy was instituted twenty to 159 days after operation and the animals were killed three to seventeen days after treatment was started. Chemical studies of the serum calcium showed a correlation between the postoperative administration period and the dosage. Histologically, the primary response to treatment was characterized by an eosin staining zone (hypocalcified); the secondary response, by a hematoxylin staining zone. In most instances, a sharp, hematoxylin staining ring occurs at the border of the preexperimental and postexperimental dentin and, in half the cases, cytologic changes were observed in the active ameloblasts. The findings indicate that massive doses of calciferol (vitamin D) "do not necessitate the presence of the parathyroids to exert their effects.—*Am. J. Path.*, 13:971, November 1937.

HAMILTON ROBINSON.

## Leukoplakia and Tobacco

By F. RONCHESE

THE author reports two identical cases of leukoplakia buccalis, one involving a man who smokes and chews tobacco and the other a non-smoking woman. He suggests that the cause of leukoplakia is as yet unknown. In Case 1, a man, aged 59, gave a history of having noticed a rash on the roof of his mouth for the past three years. Each elevation seemed to be centered by a "pore" and became extremely painful when he smoked excessively. Discontinuance of smoking afforded relief. The author does not give his treatment, but reports that, after a year of observation, the elevations on the palate became fewer in number. The patient did not relinquish smoking. In Case 2, a colored woman, aged 50, had grayish elevations on the palate identical to those in Case 1. These were of ten years' duration and Wassermann tests had been repeatedly negative. The patient gave no history of smoking or of eating hot or spicy foods. A biopsy section was examined and a diagnosis of leukoplakia made. —*Arch. Dermat. & Syph.*, 36:1122-1124, 1937.

FRANK ALLEN.

## Silikatzementfüllung und Zahnpulpa (Silicate Cement Fillings and the Tooth Pulp)

By E. DOLDER

THE author placed silicate cement fillings in twenty-four teeth (molars and premolars) of children ranging from 9 to 15 years of age. Fifteen of the teeth were free from caries, nine showed slight superficial caries of the enamel and all of the teeth had been condemned for extraction for orthodontic reasons. Cavities were slowly prepared into the dentin with wet carborundum stones in each case beyond the area of interglobular spaces. The minimum distance of the cavity floor to the pulp chamber as observed from histologic section was 0.4 mm.; the maximum, 2.7 mm.,

and the average, 1.2 mm. Immediately after preparation, all of the cavities were disinfected with alcohol and dried with warm air. "Syntrex" and "Salvit" and amalgam were the filling materials used. In some cases, an antiseptic, Di-mercuro-chloro-hexamethylentetramin, was mixed with the "Syntrex." The "Salvit" filling material already contained this substance. The fillings remained in the teeth from one to four months, when they were extracted under procaine anesthesia. From this work, the author draws the following conclusions: "1. Correctly applied, a filling of silicate cement . . . has no damaging influence on the living pulp. 2. Antiseptics added to the silicate cement have no particular influence on the living pulp. 3. Amalgam used as filling material has the same unimportant influence on the pulp as silicate cement." (In the light of clinical experience and from experimental evidence, the first of these conclusions should be qualified for safety and include only those silicate fillings at a distance of more than 0.4 mm. from the vital pulp.) —*Deutsche Zahnärztl. Wchnschr.*, 39, August 1936.

GRANT VAN HUYSEN.

## Failure of Abundant Sunshine to Protect Against Rickets

By C. MOORE, J. BRODIE, A. THORNTON, A. LESEM and O. CORDUA

THIS comparative clinical study covers 943 5-year-old children in two meteorologically different localities on the Pacific coast. The localities were selected because of their different climatic conditions. The procedure for examination in the two cities was similar. Physicians gave the physical examinations and roentgenograms were made of osseous structures. Dental examinations were made by the family dentist. Nutrition histories were taken. More than 90 per cent of the children exhibited three or more signs of rickets and maternal histories indicated that about 80 per cent of the children had received medicinal antirachitic treatment. The percentage of rickets was nearly as great among the children of the sunny San Diego region as among those of cloudy Portland. Of the several items of comparison, the dental findings show the greatest degree of variance between the children of the two regions. Of the San Diego children, 54.5 per cent possessed excellent teeth with no cavities or fillings, as compared with 22.4 per cent of the Portland children. Mathematical correlations between cariousness of teeth and certain common signs of rickets are consistently negative or else approach zero, indicating a question whether carious teeth are a sign of rickets. (In view of the high figures quoted for percentages of children supposedly immune to caries, deductions relating to correlated findings are of questionable value.)—*Am. J. Dis. Child.*, 54: 1227, December 1937.

VIRGIL D. CHEYNE.

## Saturation of a Scurvy Patient with Small Doses of Ascorbic Acid; Consideration of the Daily Human Requirement

By P. SCHULTZER

WHEN massive doses (300-600 mg.) of vitamin C are given daily, clinical symptoms disappear and capillary resistance returns to normal in a few days, but saturation is reached only after several weeks. The same results were obtained with small doses (40 mg.) daily. The total quantity of vitamin C necessary to reach saturation depends on the size of the daily dose given. From the figures obtained, it was found that the amount of the vitamin required for saturation is smaller than commonly supposed, 40 mg. daily being curative.—*Biochem. J.*, 31:1934, 1937.

MARTIN DEAKINS.

## Immediate Treatment of Facial Fractures

By STEWART GORDON

RESTORATION of function and minimizing disfigurement are most important. Roentgenographic examination is very important to diagnosis. Usually, the malar bone will stay in position when so placed. The same is true of the nasal bones. Fractures of the alveolar bone are treated by interdental ligation. Bilateral horizontal fractures are reduced by manipulation of bone fragments and checked by the occlusion of the teeth. The author advocates holding bones in position by a "Jury-mast attached to a head-piece of plaster." A tooth in the line of fracture should be removed. Teeth are brought into occlusion and stabilized. The upper and lower teeth are fastened together with tie wires. The teeth usually fastened are right and left bicuspids and central incisors. Splinting is usually maintained for five weeks. Hygienic *A. J.*, 37:440, November 1937.

L. H. GARRISON.

# INCIDENTS OF PRACTICE

## Fractured Root Retained in Jaw

By Joseph Henry Kenna, D.D.S., Paterson, N. J.

A man, aged 43, had been kicked in the mouth while playing football in 1906, and as a result the two upper central incisors were injured. He did not consult a dentist until November 1, 1937, and then only with regard to the left central incisor, which was black and had

a granuloma at the end of the root. The right central incisor with the broken root-end responded positively to all tests for vitality of the pulp, including a test with Cameron's vitalitester. Evidently, this tooth was broken at the root end at the time of the accident in 1906, but it did not lose its vitality or its color.

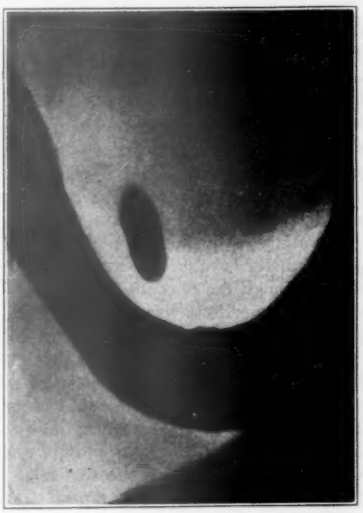
115 Market Street.

## Stone in Sublingual Gland: Report of a Case

By H. G. Brodows, D.D.S., B.S., New York City.

*History.*—Mrs. J. P., aged 53, consulted her dentist because of pain under the lower left bicuspid region of a denture. The patient had been wearing full dentures for nine years, and the dentist, seeing no external cause for the pain, roentgenographed the region, and interpreted the film, shown in the accompanying illustration, as indicating cementoma or odontoma of some sort, and referred the case to this office for diagnosis.

The chief complaint was dryness and a burning sensation in the mouth for the past nine years. The patient was born in Austria. She had three sons, three brothers and two sisters, all living except one brother, who died from a heart condition. Since the burning



sensation appeared, several years ago, the patient had lost from 25 to 30 pounds, the present weight being 151 pounds. She had had the common childhood diseases. A "running ear," a condition present at birth, had continued up to the present time.

About nine years previously, the patient developed paralysis of the right side of face, and, on the advice of her physician, all remaining (ten) teeth were removed. An alveolectomy was performed in preparation for full dentures. After this operation, the digestive disturbances, coppery taste, dryness and burning sensation of mouth were first experienced. The patient visited certain clinics,

where "nerve tonics" were prescribed, with no relief. In a few weeks, the paralysis had disappeared and along with it the coppery taste; the digestive disturbances, dryness and burning sensation persisting. There was considerable difficulty in digesting food, meats being most difficult to digest and milk fairly digestible. During meals, the dryness and burning sensation of the mouth increased. Various clinics were visited, with no relief. A Turkish bath afforded complete relief from the symptoms for the short period spent in the bath. The patient had discontinued use of "nerve medicine" about two years previously and made no other attempts at treatment.

*Examination.*—Clinical examination revealed enlargement and inflammation of the left sublingual gland. There was no exudation of pus on pressure, nor swelling of the floor of the mouth or submaxillary region. On passing a fine probe through the duct, a calcific mass could be felt deep in the substance of the gland. A lateral plate and occlusal film revealed an ovoid-shaped calcific mass deep in the floor of the mouth.

*Operation.*—November 19, 1937, under local anesthesia, a fine platinum probe was passed through the duct into the body of the gland until the stone was reached. With the probe in position, a small incision extending downward into the duct was made through the superior surface of the gland. The probe was removed, and a small amount of active pus evacuated. A larger silver probe was inserted in the small incision, bluntly dissecting the gland until the stone was felt. The gland was then distended by digital pressure in the submaxillary region, the college pliers were passed into the gland and the stone was removed. The specimen measured 1.5 by 0.7 cm. The nucleus was whiter and harder in consistency than the concentrically formed outer layers.

One suture was placed, the anterior portion of the incision being left open for drainage. Healing was rapid and uneventful.

369 East One Hundred Forty-Ninth Street.

## Perborate as a Bleaching Agent

By J. Clarence Salvas, D.D.S., Philadelphia, Pa.

Bleaching teeth is, at best, more or less of an unsatisfactory operation. Although we may succeed in restoring the color of a tooth, it is seldom permanent. This may be due to faulty technic. The methods employed involve more or less chemistry. The technic is exacting and neglect of any detail of the operation means unsatisfactory results. W. C. Marsh, of Philadelphia, reports that sodium perborate is a very satisfactory bleaching agent. The method of using it is simple and it does not cauterize the soft tissues. Therefore, the use of a rubber dam is unnecessary.

The tooth is very carefully prepared, the operator removing as much of the discoloration mechanically as possible. The canal is filled to within a third of the orifice and the cavity thoroughly washed. A small amount of the perborate is placed on a glass slab and one drop of distilled water added, to make a thick paste. This paste is packed into the cavity and the upper portion of the cavity sealed with a temporary cement. This is allowed to remain for several days, after which, if the color is not entirely restored, a second application may be made. When the bleaching is finished, the cavity is thoroughly dried and lined with a light cream or pure white cement and the cavity finally closed with any material that the operator may find best suited to the case.

255 South Seventeenth Street.

## Thermotherapy Versus Frigotherapy

By W. I. Jones, D.D.S., Columbus, Ohio.

Much confusion seems to exist in the minds of the laity and sometimes in the minds of physicians and dentists regarding the use of hot or cold compresses in the treatment of inflammation.

Inflammation is a vascular and cellular response to injury. It may be traumatic, chemical or bacteriologic in origin, but no matter what the fundamental basis for the inflammatory process is, the use of cold in nearly all cases is of little value and may be, and usually is, harmful, because it retards circulation by contracting

the blood vessels, slows chemical reaction and prevents phagocytosis.

Heat, one of the most elementary and important healing agents that can be used in the presence of infection and its accompanying inflammation, is just the reverse in its effects.

Accelerating almost all chemical reactions and acting as a bacteriostatic, it dilates the blood vessels, thereby increasing the flow of blood, with its increased army of leukocytes, to the inflamed parts, and engulfing and destroying the invading army of bacteria. Heat is the treatment of choice, and it should be maintained until resolution takes place or a phlegmon is formed that can be opened and drained.

Inflammation persists because there are not enough leukocytes present to overcome the invading army of bacteria or they do not reach the area soon enough; and one of the best means of keeping the leukocytes from reaching the inflamed region is the cold application.

I have stressed the importance of the use of heat so much that perhaps some of my readers will think there is no therapeutic value in cold in inflammatory conditions. There is perhaps some advantage in cold compresses in the case of an active hyperemia following traumatic injury, such as a sprain or a blow on the eye; but, even in these cases, the cold application must be used immediately, in the hope—and it is mostly a hope—that the cold may contract the blood vessels and prevent the inrush of blood to the injured parts, producing an ischemia and thus aborting swelling and ecchymosis. However, if stasis intervenes, cold will be of no avail and is positively contraindicated.

Nearly all inflammations that the dentist is called on to treat are bacteriologic, and, in such cases, cold should never be used, for the reasons already given.

Frequently, a dentist sees a case of cellulitis of the face and neck in which the dentist or physician or the friends of the patient have advised the use of cold applications.

Such a patient should be put to bed, the face and neck bandaged and wet dressings applied with plenty of heat. A soft diet, with plenty of fluids, and an anodyne for the relief of pain are prescribed, until resolution or suppuration, when the knife is used.

327 East State Street.

# MISCELLANY

## NEWS

### Homecoming Clinic of the University of Illinois College of Dentistry

The annual Homecoming Clinic of the University of Illinois College of Dentistry, held December 8, 1937, was made the occasion of a celebration of the occupation of the new building. After a tour of the building by the alumni, an oral surgery clinic was presented by Frederick B. Moorehead and his staff in the new surgical amphitheater. A luncheon, which was served on the tenth floor, was followed by the regular business meeting of the alumni association and later by presentation by Stanley D. Tylman of a motion picture on the construction of a fixed bridge in the mouth of a patient, a film made in the division of crowns and fixed partial dentures of the department of prosthetic dentistry of the College of Dentistry. In the evening a dinner at the Lake Shore Athletic Club was attended by the faculty and the alumni.

### Deaths

*Ball, W. L.*, Elwood, Ind.; Indiana University School of Dentistry, 1923; died November 8; aged 37.

*Bebelheimer, Bruce G.*, Drexel Hill, Pa.; Baltimore College of Dental Surgery, 1903; died October 22; aged 38.

*Brown, George Arthur*, Springfield, Ore.; Chicago College of Dental Surgery, 1910; died October 28; aged 57.

*Brown, R. V.*, Livingston, Mont.; Indiana University School of Dentistry, 1918; died October 24.

*Curl, R. H.*, Albany, Ore.; licensed by registration, 1887; died October 29.

*Duncan, James*, Warsaw, Ind.; Indiana University School of Dentistry, 1907; died August 19; aged 55.

*Faust, W. F.*, Waupun, Wis.; School of Dentistry, University of Pennsylvania, 1889; died October 22; aged 69.

*Ferris, Henry Clay*, New York City; New York College of Dentistry, 1892; died November 10.

*Hamilton, F. A.*, Indianapolis, Ind.; Indiana University School of Dentistry, 1895; died September 3; aged 65.

*Hammer, Oscar W.*, St. Louis, Mo.; Marion-Sims Dental College, 1899; died October 30.

*Hanson, Oscar W.*, Madison, S. D.; Northwestern University Dental School, 1906; president South Dakota State Dental Society, 1923; died July 5; aged 56.

*Henderson, George Henry*, Chicago, Ill.; Royal College of Surgeons, Toronto University, 1886; died October 31; aged 71. Dr. Henderson was chiefly interested in full denture work. For several years, he served as librarian of the Illinois State Dental Society.

*Hendricks, N. J.*, Cincinnati, Ohio; University of Illinois, College of Dentistry, 1902; died October 19; aged 63.

*Lerche, Thorleif Iversen*, Chicago, Ill.; University of Illinois, College of Dentistry, 1909; died November 10; aged 55.

*Mast, G. L.*, Gilmore City, Iowa; Creighton University, College of Dentistry, 1927; died November 1.

*Maupin, Malcolm M.*, Cincinnati, Ohio; Ohio College of Dental Surgery, 1908; died October 10; aged 61.

*Moore, C. A.*, Sioux City, Iowa; died October 7; aged 61.

*Moore, Claud M.*, Phoenix, Ariz.; University of Michigan, College of Dentistry, 1911; died December 2; aged 50.

*Morrisey, William J.*, Reedsville, Wis.; Chicago College of Dental Surgery, 1907; died October 9; aged 57.

*Newberger, L. R.*, Bedford, Ind.; Indiana University School of Dentistry, 1918; died August 12.

*Ross, Frank A.*, Chicago, Ill.; Northwestern University Dental School, 1896; died September 7; aged 72.

*Sandner, A. C.*, Milwaukee, Wis.; Marquette University Dental School, 1919; died November 28; aged 39.

*Stephens, Russell J.*, Marion, Ind.; Indiana University School of Dentistry, 1926; died August 16.

*Webber, S. T. B.*, Chicago, Ill.; Chicago College of Dental Surgery, 1904; died August 14; aged 61.

# DIRECTORY OF STATE SOCIETY OFFICERS AND DATES OF MEETINGS, 1937-1938

## ALABAMA DENTAL ASSOCIATION

Harry Bradford, President.....Medical Arts Bldg., Birmingham
O. L. F. Haggard, President Elect.....Gadsden
Hunter S. Allen, Secretary.....First Nat'l Bank Bldg., Birmingham
J. Sharpe Gillespy, Treasurer.....First Nat'l Bank Bldg., Birmingham
Dates of next annual meeting: April 11-13, 1938.
Place of next annual meeting: Tutwiler Hotel, Birmingham.

## ARIZONA STATE DENTAL SOCIETY

K. E. Steninger, President.....Hayden
Franklin R. Smith, President Elect.....Professional Bldg., Phoenix
John V. Cogan, Secretary-Treasurer.....Second and Speedway, Tucson
Dates of next annual meeting: April 23-24, 1938.
Place of next annual meeting: Tucson.

## ARKANSAS STATE DENTAL ASSOCIATION

M. D. Gibbs, President.....Medical Arts Bldg., Hot Springs
H. S. Neel, President Elect.....Stuttgart
I. M. Sternberg, Secretary-Treasurer.....Merchants Nat'l Bank Bldg., Fort Smith
Dates of next annual meeting: May 16-18, 1938.
Place of next annual meeting: Marion Hotel, Little Rock.

## CALIFORNIA STATE DENTAL ASSOCIATION

Henry C. Petray, President.....1904 Franklin St., Oakland
Howard B. Kirtland, President Elect.....San Luis Obispo
Frederick T. West, Secretary.....2180 Washington St., San Francisco
John W. Leggett, Treasurer.....490 Post St., San Francisco
Dates of next annual meeting: April 4-6, 1938.
Place of next annual meeting: Civic Auditorium, Stockton.

## SOUTHERN CALIFORNIA STATE DENTAL ASSOCIATION

J. C. A. Harding, President.....First Nat'l Bldg., San Diego
Stanley Rice, President Elect.....1048 Roosevelt Bldg., Los Angeles
Morris J. Thompson, Vice President.....1106 Roosevelt Bldg., Los Angeles
Francis J. Conley, Secretary.....804 Professional Bldg., Los Angeles
Harry H. Bleecker, Treasurer.....919 Roosevelt Bldg., Los Angeles
Dates of next annual meeting:
Place of next annual meeting: Coronado Beach, San Diego.

## COLORADO STATE DENTAL ASSOCIATION

T. J. Rogers, President.....432 Republic Bldg., Denver
Oliver H. Devitt, Vice President.....523 Republic Bldg., Denver
R. L. Christy, Secretary.....820 Majestic Bldg., Denver
C. J. Brown, Treasurer.....La Junta
Dates of next annual meeting: June 20-22, 1938.
Place of next annual meeting: Stanley Hotel, Estes Park.

## CONNECTICUT STATE DENTAL ASSOCIATION

A. B. Rosoff, President.....265 Church St., New Haven
J. J. Myers, President Elect.....Bridgeport
C. W. Vivian, Secretary-Treasurer.....58 Elbridge Road, New Britain
Dates of next annual meeting: May 4-6, 1938.
Place of next annual meeting: New Haven.

## DELAWARE STATE DENTAL SOCIETY

W. Ralph Staats, President.....Medical Arts Bldg., Wilmington
C. R. Cannon, Vice President.....Georgetown
Richard R. Wier, Secretary.....1117 Adams St., Wilmington
P. A. Traynor, Treasurer.....805 Washington St., Wilmington
Dates of next annual meeting: January 1938.
Place of next annual meeting: Wilmington.

## DISTRICT OF COLUMBIA DENTAL SOCIETY

John P. Burke, President.....Colorado Bldg., Washington, D. C.
James W. Brown, President Elect.....1726 Eye St. N. W., Washington, D. C.
Daniel F. Lynch, Secretary-Treasurer.....1149 16th St. N. W., Washington, D. C.
Dates of next annual meeting: March 6-9, 1938.
Place of next annual meeting: Mayflower Hotel, Washington, D. C.
(Five-State Postgraduate Clinic)

## FLORIDA STATE DENTAL SOCIETY

R. D. Cummins, President.....Equitable Bldg., St. Petersburg
R. P. Taylor, President Elect.....St. James Bldg., Jacksonville
Lloyd N. Harlow, Secretary-Treasurer.....Bradenton
Dates of next annual meeting: November 10-12, 1938.
Place of next annual meeting: Jacksonville.

## GEORGIA DENTAL ASSOCIATION

Paul K. McGee, President.....Waycross
Carl Betts, President Elect.....Rome
R. H. Murphy, Secretary.....920 Georgia Casualty Bldg., Macon
W. A. Jenkins, Ass't Secretary.....920 Georgia Casualty Bldg., Macon
Frank Tilleary, Treasurer.....Columbus
Dates of next annual meeting: May 16-18, 1938.
Place of next annual meeting: Dempsey Hotel, Macon.

## DENTAL SOCIETY OF HAWAII

M. I. Connor, President.....Palama Settlement, Honolulu
J. K. Kahaleanu, President Elect.....1136 Punchbowl St., Honolulu
John Dawe, Secretary.....Palama Settlement, Honolulu
R. Ipponsugi, Treasurer.....River and Beretania Sts., Honolulu
Dates of next annual meeting:
Place of next annual meeting:

## IDAHO STATE DENTAL ASSOCIATION

R. C. Peterson, President.....Lewiston
E. S. Robinson, President Elect.....Gooding
H. B. Colver, Secretary.....Eastman Bldg., Boise
P. G. Flack, Treasurer.....Boise
Dates of next annual meeting:
Place of next annual meeting:

## ILLINOIS STATE DENTAL SOCIETY

E. C. Pendleton, President.....3650 Lake Shore Drive, Chicago
Ben H. Sherrard, President Elect.....300 Rock Island Bank Bldg., Rock Island
C. N. Newlin, Secretary.....627 Jefferson Bldg., Peoria
E. P. Boulger, Treasurer.....17 S. Crawford Ave., Chicago
Dates of next annual meeting: May 10-12, 1938.
Place of next annual meeting: Peoria, Ill.

## INDIANA STATE DENTAL ASSOCIATION

H. J. Longcamp, President.....Aurora
A. A. Spears, President Elect.....Brazil
A. R. Ross, Secretary.....Murdock Building, Lafayette
William Bogie, Treasurer.....Vincennes
Dates of next annual meeting: May 16-18, 1938.
Place of next annual meeting: Claypool Hotel, Indianapolis.

## IOWA STATE DENTAL SOCIETY

A. W. Bryan, President.....Iowa City
Mort Henkin, President Elect.....Sioux City
John Scholten, Secretary.....810 Dows Bldg., Cedar Rapids
L. C. Dow, Treasurer.....Marion
Dates of next annual meeting: May 3-5, 1938.
Place of next annual meeting: Blackhawk Hotel, Davenport.

## KANSAS STATE DENTAL ASSOCIATION

J. Wesley Lucas, President.....First Nat'l Bank Bldg., Wichita
H. L. Bunker, President Elect.....Junction City
Fred A. Richmond, Secretary.....Huron Bldg., Kansas City
W. T. Triplett, Treasurer.....Salina
Dates of next annual meeting: April 24-27, 1938.
Place of next annual meeting: Allis Hotel, Wichita.

## KENTUCKY STATE DENTAL ASSOCIATION

R. P. Thomas, President.....914 Heyburn Bldg., Louisville
J. F. Owen, President Elect.....800 Fayette Bank Bldg., Lexington
J. H. Fullenwider, Secretary-Treasurer.....1101 Heyburn Bldg., Louisville
Dates of next annual meeting: April 4-6, 1938
Place of next annual meeting: Brown Hotel, Louisville.

## LOUISIANA STATE DENTAL SOCIETY

Louis P. Laville, President.....Plaquemine
A. C. Broussard, Vice President.....Maison Blanche, New Orleans
Julian S. Bernhard, Secretary.....417 Medical Arts Bldg., Shreveport
Oscar J. Ory, Treasurer.....Garyville
Dates of next annual meeting: April 28-30, 1938.
Place of next annual meeting: Bentley Hotel, Alexandria.

## MAINE DENTAL SOCIETY

Giles C. Grant, President.....655 Congress St., Portland
Philip F. M. Gilley, Vice President.....Southwest Harbor
George A. Phillips, Secretary.....31 Central St., Bangor
Darius S. Roberts, Treasurer.....655 Congress St., Portland
Dates of next annual meeting: June 27-28, 1938.
Place of next annual meeting: Eastland Hotel, Portland.

## MARYLAND STATE DENTAL ASSOCIATION

C. O. Diehl, President ..... Hagerstown
O. H. Gaver, President Elect ..... Medical Arts Bldg., Baltimore
Meyer Eggnatz, Secretary ..... Medical Arts Bldg., Baltimore
John M. Hyson, Treasurer ..... 2128 St. Paul St., Baltimore
Dates of next annual meeting: May 2-3, 1938.
Place of next annual meeting: Emerson Hotel, Baltimore.

## MASSACHUSETTS DENTAL SOCIETY

John J. Goodridge, President ..... 77 Broad St., Lynn
Frank W. Rounds, President Elect ..... 270 Commonwealth Ave., Boston
Philip E. Adams, Secretary ..... 106 Marlborough St., Boston
Harold E. Tingley, Ass't Secretary ..... 19 Bay State Road, Boston
Joseph T. Paul, Treasurer ..... 419 Boylston St., Boston
Dates of next annual meeting: April 25-28, 1938.
Place of next annual meeting: Hotel Statler, Boston.

## MICHIGAN STATE DENTAL SOCIETY

U. Garfield Rickert, President ..... University of Michigan, Ann Arbor
J. Orton Goodsell, President Elect ..... 2nd Nat'l Bank Bldg., Saginaw
William R. Davis, Secretary ..... Michigan Dept. of Health, Lansing
E. J. Chamberlin, Treasurer ..... Ashton Bldg., Grand Rapids
Dates of next annual meeting: April 18-20, 1938.
Place of next annual meeting: Detroit.

## MINNESOTA STATE DENTAL ASSOCIATION

E. A. Rieke, President ..... 527 Lowry Medical Arts Bldg., St. Paul
George M. Damon, President Elect ..... 730 LaSalle Bldg., Minneapolis
L. M. Cruttenden, Secretary ..... 481 Lowry Medical Arts Bldg., St. Paul
A. R. Schmid, Treasurer ..... Worthington
Dates of next annual meeting: February 22-24, 1938.
Place of next annual meeting: Municipal Auditorium, St. Paul.

## MISSISSIPPI DENTAL ASSOCIATION

A. H. Henderson, President ..... Greenville
J. F. Kilpatrick, President Elect ..... Clarksdale
George P. Evans, Secretary-Treasurer ..... Jackson
Dates of next annual meeting: April 25-27, 1938.
Place of next annual meeting: Lamar Hotel, Meridian.

## MISSOURI STATE DENTAL ASSOCIATION

George T. Reily, President ..... Fulton
R. H. Miller, President Elect ..... 6233 Delmar Blvd., St. Louis
C. W. Digges, Secretary-Treasurer ..... Columbia
Dates of next annual meeting: May 8-9, 1938.
Place of next annual meeting: Columbia.

## MONTANA STATE DENTAL ASSOCIATION

J. R. Burgess, President ..... Glasgow
W. L. Beal, President Elect ..... Anaconda
T. T. Rider, Secretary-Treasurer ..... 9 Higgins Block, Missoula
Dates of next annual meeting: May 5-7, 1938.
Place of next annual meeting: Helena.

## NEBRASKA STATE DENTAL ASSOCIATION

F. T. Daly, President ..... Cambridge
G. H. Fritz, President Elect ..... Medical Arts Bldg., Omaha
F. A. Pierson, Secretary ..... 1112 Federal Securities Bldg., Lincoln
G. L. Spencer, Treasurer ..... Sharp Bldg., Lincoln
Dates of next annual meeting: May 16, 1938.
Place of next annual meeting: Lincoln.

## NEVADA STATE DENTAL ASSOCIATION

A. A. Cozzalio, President ..... First Nat'l Bank Bldg., Reno
Charles Cozzalio, President Elect ..... Truckee, Calif.
H. E. Cafferata, Secretary-Treasurer ..... First Nat'l Bank Bldg., Reno
Dates of next annual meeting: June 4, 1938.
Place of next annual meeting: Reno.

## NEW HAMPSHIRE DENTAL SOCIETY

A. R. Fogg, President ..... Hanover
G. A. Conboy, Vice President ..... Keene
F. E. Williams, Secretary ..... Manchester
W. A. Young, Treasurer ..... Concord
Dates of next annual meeting: June 6-7, 1938.
Place of next annual meeting: Hotel Randall, North Conway.

## NEW JERSEY STATE DENTAL SOCIETY

Harry L. Bull, President ..... 921 Bergen Ave., Jersey City
Earl L. D. Hester, President Elect ..... 34 East Palisade Ave., Englewood
Craft A. Hopper, Vice President ..... 534 Broadway, Paterson
F. K. Heazelton, Secretary ..... 223 E. Hanover St., Trenton
Walter A. Schilke, Treasurer ..... 46 E. Palisade Ave., Englewood
Dates of next annual meeting: April 20-22, 1938.
Place of next annual meeting: Ambassador Hotel, Atlantic City.

## NEW MEXICO STATE DENTAL SOCIETY

George S. Westfall, President ..... Carlsbad
C. E. Hagland, President Elect ..... Albuquerque
Fred Muller, Secretary-Treasurer ..... Taos
Dates of next annual meeting: June 1938.
Place of next annual meeting: Carlsbad.

## DENTAL SOCIETY OF THE STATE OF NEW YORK

Edwin I. Harrington, President ..... Watertown
Russell W. Tench, President Elect ..... 745 Fifth Ave., New York City
Paul Jones, Vice President ..... 89 East Avenue, Rochester
Charles A. Wilkie, Secretary ..... 1 Hanson Place, Brooklyn
George D. Greenwood, Treasurer ..... Mercantile Bldg., Rochester
Dates of next annual meeting: May 10-13, 1938.
Place of next annual meeting: Hotel Syracuse, Syracuse.

## NORTH CAROLINA DENTAL SOCIETY

J. F. Reece, President.....Lenoir
G. Fred Hale, President Elect.....Raleigh
W. T. Smith, Vice President.....Wilmington
F. O. Alford, Secretary-Treasurer.....Charlotte
Dates of next annual meeting: May 2-4, 1938.
Place of next annual meeting: Winston Salem.

## NORTH DAKOTA STATE DENTAL ASSOCIATION

W. S. Shaw, President.....Fargo
A. O. Schjeldahl, President Elect.....Valley City
Russell A. Sand, Secretary.....Fargo
L. C. Schmitz, Treasurer.....Jamestown
Dates of next annual meeting: May 16-18, 1938.
Place of next annual meeting: Minot.

## OHIO STATE DENTAL SOCIETY

Walter J. Pryor, President.....669 Rose Bldg., Cleveland
E. N. Bach, President Elect.....Second Nat'l Bank Bldg., Toledo
Edward C. Mills, Secretary.....255 E. Broad St., Columbus
Harry Cope, Treasurer.....327 E. State St., Columbus
Dates of next annual meeting: November 1938.
Place of next annual meeting: Cleveland.

## OKLAHOMA STATE DENTAL SOCIETY

W. S. Phillips, President.....McAlester
F. J. Reichmann, President Elect.....Medical Arts Bldg., Oklahoma City
O. W. Boyer, Secretary.....Perry
O. F. Sinks, Treasurer.....504 Medical Arts Bldg., Tulsa
Dates of next annual meeting: April 17-20, 1938.
Place of next annual meeting: Tulsa.

## OREGON STATE DENTAL ASSOCIATION

M. C. Harris, President.....Tiffany Bldg., Eugene
Neil M. Bain, President Elect.....Selling Bldg., Portland
F. W. Hollister, Secretary-Treasurer.....Selling Bldg., Portland
Dates of next annual meeting:
Place of next annual meeting: Portland.

## PANAMA CANAL ZONE DENTAL SOCIETY

R. B. Tobias, President.....Ft. Clayton, Canal Zone
L. H. Daniel, Secretary-Treasurer.....Balboa, Canal Zone
Dates of next annual meeting:
Place of next annual meeting:

## PENNSYLVANIA STATE DENTAL SOCIETY

Fred D. Miller, President.....1122 12th Avenue, Altoona
Raymond M. Walls, President Elect.....48 E. Market St., Bethlehem
Sanford D. Lawyer, Secretary.....Germantown Professional Bldg., Philadelphia
John H. Corcoran, Treasurer.....Scranton Life Bldg., Scranton
Dates of next annual meeting: May 3-5, 1938.
Place of next annual meeting: Benjamin Franklin Hotel, Philadelphia.

## DENTAL SOCIETY OF THE PHILIPPINE ISLANDS

Dates of next annual meeting:
Place of next annual meeting:

## DENTAL ASSOCIATION OF PUERTO RICO

Jose Vicente, President ..... San Juan
Juan Font Suarez, Secretary ..... San Truce
L. Ramirez Santibenez, Treasurer ..... San Juan
Dates of next annual meeting:
Place of next annual meeting:

## RHODE ISLAND STATE DENTAL SOCIETY

Mark Tishler, President ..... 1 School Street, Newport
Philip J. Conley, Vice President ..... 1291 Main Street, West Warwick
Edwin K. Devine, Secretary ..... 170 Westminister St., Providence
Edward C. Morin, Treasurer ..... 188 Main Street, Pawtucket
Dates of next annual meeting: January 12-13, 1938.
Place of next annual meeting: Providence.

## SOUTH CAROLINA STATE DENTAL ASSOCIATION

G. A. Bunch, President ..... Cheraw
J. A. Harper, President Elect ..... Charleston
P. H. Hair, Secretary-Treasurer ..... Spartanburg
Dates of next annual meeting:
Places of next annual meeting:

## SOUTH DAKOTA STATE DENTAL SOCIETY

R. I. Wood, President ..... Sturgis
F. M. Matteson, President Elect ..... Highmore
Ernest W. Elmen, Secretary ..... Sioux Falls
J. W. King, Treasurer ..... Aberdeen
Dates of next annual meeting: May 23-24, 1938.
Place of next annual meeting: Watertown.

## TENNESSEE STATE DENTAL ASSOCIATION

J. M. Rodgers, President ..... Chattanooga Bank Bldg., Chattanooga
H. A. Graves, President Elect ..... Doctors Bldg., Nashville
E. J. Justis, Secretary-Treasurer ..... 708 Exchange Bldg., Memphis
Dates of next annual meeting: May 9-12, 1938.
Place of next annual meeting: Hotel Patton, Chattanooga.

## TEXAS STATE DENTAL SOCIETY

R. C. Cooley, President ..... 2517 Gulf Bldg., Houston
L. Willard Ogle, Secretary-Treasurer ..... 433 Medical Arts Bldg., Dallas
Dates of next annual meeting: April 25-28, 1938.
Place of next annual meeting: San Antonio.

## UTAH STATE DENTAL ASSOCIATION

E. W. Lambert, President.....Judge Bldg., Salt Lake City
E. B. Thatcher, Vice President.....First Nat'l Bank Bldg., Ogden
K. W. Merrill, Secretary-Treasurer.....Medical Arts Bldg., Salt Lake City
Dates of next annual meeting:
Place of next annual meeting: Salt Lake City.

## VERMONT STATE DENTAL SOCIETY

Edward B. Jenney, President.....Rutland
W. Fay Mann, Vice President.....Barre
Howard H. Reid, Secretary.....Barre
Howard F. Killary, Treasurer.....Burlington
Dates of next annual meeting: May 18-19, 1938.
Place of next annual meeting: Rutland.

## VIRGINIA STATE DENTAL ASSOCIATION

A. M. Wash, President.....Medical Arts Bldg., Richmond
W. H. Wunder, President Elect.....Woodstock
J. E. John, Secretary-Treasurer.....Medical Arts Bldg., Roanoke
Dates of next annual meeting: April 4-6, 1938.
Place of next annual meeting: Richmond.

## WASHINGTON STATE DENTAL ASSOCIATION

J. H. Whisler, President.....Field & Lease Bldg., Centralia
J. H. Winstanley, President Elect.....Doneen Bldg., Wenatchee
A. W. Jeffrey, Secretary-Treasurer.....Medical & Dental Bldg., Seattle
Dates of next annual meeting:
Place of next annual meeting: Vancouver.

## WEST VIRGINIA STATE DENTAL SOCIETY

E. D. Douglass, President.....Parkersburg
L. A. Stark, President Elect.....Clarksburg
C. G. Anderson, Secretary.....Mt. Hope
John S. Stone, Treasurer.....Clarksburg
Dates of next annual meeting: May 16-18, 1938.
Place of next annual meeting: Wheeling.

## WISCONSIN STATE DENTAL SOCIETY

E. C. Wetzel, President.....Majestic Bldg., Milwaukee
O. H. Moen, President Elect.....Watertown
E. E. Parkinson, Secretary.....207 Washington Bldg., Madison
O. P. Collins, Treasurer.....Public Service Bldg., Kenosha
Dates of next annual meeting: April 25-28, 1938.
Place of next annual meeting: Schroeder Hotel, Milwaukee.

## WYOMING STATE DENTAL ASSOCIATION

T. J. Drew, President.....Casper
L. A. French, Vice President.....Thermopolis
J. D. McNiff, Secretary.....208 Grand Avenue, Laramie
J. E. Beal, Treasurer.....Casper
Dates of next annual meeting:
Place of next annual meeting: Rawlins.

# ANNOUNCEMENTS

ANNOUNCEMENTS must be received by the fifth day of the month in order to be published in the forthcoming issue of THE JOURNAL.

## CALENDAR OF MEETINGS

American Dental Association, St. Louis, Mo., October 24-28.

American Academy of Restorative Dentistry, St. Louis, Mo., October 22-23.

American Society for the Advancement of General Anesthesia in Dentistry, New York City, fourth Monday in March and October.

American Society of Orthodontists, Los Angeles, July 11-14.

Chicago Dental Society Midwinter Meeting, February 14-18.

Five-State Postgraduate Clinic, Washington, D. C., March 6-9.

Southwestern Society of Orthodontists, Dallas, Texas, March 6-9.

Thomas P. Hinman Midwinter Clinic, Atlanta, Ga., March 14-15.

District of Columbia Dental Society, second and fourth Tuesdays in each month from October to June at the United States Public Health Service Auditorium, Washington.

Greater Philadelphia Annual Meeting, Philadelphia, February 2-4.

Cleveland Dental Society, Cleveland, Ohio, April 4-5.

American Dental Society of Europe, Stockholm, August 1-3.

Baltimore College of Dental Surgery Alumni, Baltimore, Md., June 1-4.

University of Buffalo School of Dentistry Alumni Association, Buffalo, N. Y., February 23-25.

New York College of Dentistry Class of 1923, New York City, April 7.

St. Louis University Dental Alumni Association, St. Louis, Mo., March 23-24.

International College of Dentists, U. S. Section, Chicago, Ill., February 13.

Montreal Dental Club Clinic, at Montreal, Canada, October 12-14.

Association of French-Speaking Dentists of North America, Montreal, Canada, June 2-5.

ARPA Internationale, Prague, Czechoslovakia, August 26-28.

## STATE SOCIETIES

February

Minnesota, at St. Paul (22-24)

April

Alabama, at Birmingham (11-13)
Arizona, at Tucson (23-24)
California, at Stockton (4-6)
Kansas, at Wichita (24-27)
Kentucky, at Louisville (4-6)
Louisiana, at Alexandria (28-30)
Massachusetts, at Boston (25-28)
Michigan, at Detroit (18-20)
Mississippi, at Meridian (25-27)
New Jersey, at Atlantic City (20-22)
Oklahoma, at Tulsa (17-20)
Texas, at San Antonio (25-28)
Virginia, at Richmond (4-6)
Wisconsin, at Milwaukee (25-28)

May

Arkansas, at Little Rock (16-18)
Connecticut, at New Haven (4-6)
Georgia, at Macon (16-18)
Illinois, at Peoria (10-12)
Indiana, at Indianapolis (16-18)
Iowa, at Davenport (3-5)
Maryland, at Baltimore (2-3)
Missouri, at Columbia (8-9)
Montana, at Helena (5-7)
Nebraska, at Lincoln (16)
New York, at Syracuse (10-13)
North Carolina, at Winston-Salem (2-4)
North Dakota, at Minot (16-18)
Pennsylvania, at Philadelphia (3-5)
South Dakota, at Watertown (23-24)
Tennessee, at Chattanooga (9-12)
Vermont, at Rutland (18-19)
West Virginia, at Wheeling (16-18)

June

Colorado, at Estes Park (20-22)
Maine, at Portland (27-28)
Nevada, at Reno (4)
New Hampshire, at North Conway (6-7)
New Mexico, at Carlsbad

November

Ohio, at Cleveland
Florida, at Jacksonville (10-12)

### STATE BOARDS OF DENTAL EXAMINERS

California, at San Francisco, May 23; at Los Angeles, June 20. Kenneth I. Nesbitt, 450 McAllister St., San Francisco, Secretary.

Iowa, at Iowa City, May 30-June 3. Hardy F. Pool, Mason City, Secretary.

Kentucky, June 14-17. Robert L. Sprau, 970 Baxter Ave., Louisville, Secretary.

New Jersey, June 27-July 2. Walter A. Wilson, 148 W. State St., Trenton, Secretary.

North Dakota, at Fargo, July 11-14. W. E. Cole, Bismarck, Secretary.

Tennessee, at Memphis, June 13. B. C. Gallimore, Commercial Bank Bldg., McKenzie, Secretary.

### GEORGIA DENTAL ASSOCIATION

The seventieth annual meeting of the Georgia Dental Association will be held May 16-18 at the Hotel Dempsey, Macon.

R. H. Murphy, *Secretary*,
920 Georgia Casualty Bldg.,
Macon.

### MICHIGAN STATE DENTAL SOCIETY

The next annual meeting of the Michigan State Dental Society will be held April 18-20 at the Hotel Statler, Detroit.

William R. Davis, *Secretary*,
Michigan Dept. of Health,
Lansing.

### MISSISSIPPI DENTAL ASSOCIATION

The next meeting of the Mississippi Dental Association will be held at Meridian, April 25-27, at the Lamar Hotel.

George P. Evans, *Secretary*,
Jackson.

### VERMONT STATE DENTAL SOCIETY

The next meeting of the Vermont State Dental Society will be held in Rutland, May 18-19.

Howard H. Reid, *Secretary*,
Barre.

### BOARD OF DENTAL EXAMINERS OF CALIFORNIA

The next examination to be conducted by the Board of Dental Examiners of California for license to practice dentistry and license to practice dental hygiene in California will be held in San Francisco commencing May 23 and in Los Angeles commencing June 20. All credentials must be in the office of the secretary at least twenty days prior to the date of the examination. Address all communications to

Kenneth I. Nesbitt, *Secretary*,
450 McAllister St.,
San Francisco.

### IOWA STATE BOARD OF DENTAL EXAMINERS

The next meeting of the Iowa State Board of Dental Examiners will be held at Iowa City, May 30-June 3. All applications properly executed together with college diploma and fee for $25 ($50 if making application under reciprocity, $10 for dental hygientists examination) must be filed with H. W. Grefe, director, Division of Licensure and Registration, State House, Des Moines.

Hardy F. Pool, *Secretary*,
Mason City.

### NORTH DAKOTA STATE BOARD OF DENTAL EXAMINERS

The North Dakota State Board of Dental Examiners will conduct the next examination of applicants for licensure at Fargo, July 11-14. Application blanks and further information can be obtained from

W. E. Cole, *Secretary*,
Bismarck.

### TENNESSEE BOARD OF DENTAL EXAMINERS

The Tennessee Board of Dental Examiners will hold examinations in Memphis June 13.

B. C. Gallimore, *Secretary*,
Commercial Bank Bldg.,
McKenzie.

### AMERICAN SOCIETY OF ORTHODONTISTS

The thirty-sixth annual meeting of the American Society of Orthodontists will be held at the Roosevelt Hotel, Los Angeles, July 11-14.

Claude R. Wood, *Secretary*,
Medical Arts Bldg.,
Knoxville, Tenn.

### SOUTHWESTERN SOCIETY OF ORTHODONTISTS

The eighteenth annual meeting of the Southwestern Society of Orthodontists will be held at the Adolphus Hotel, Dallas, Texas,

March 6-9. Essayists: Oren A. Oliver and Hermann T. Becks. Members of the American Association of Orthodontists are invited.

HARRY H. SORRELS, *Secretary,*
Medical Arts Bldg.,
Oklahoma City, Okla.

### AMERICAN SOCIETY FOR THE ADVANCEMENT OF GENERAL ANESTHESIA IN DENTISTRY

The next meeting of the American Society for the Advancement of General Anesthesia in Dentistry will be held March 28 at the Hotel Belmont Plaza, New York. Essayists: W. Harry Archer and Lawrence Lee Mulcahy.

HARRY J. FIELD, *Secretary,*
130 Market St.,
Newark, N. J.

### CLEVELAND DENTAL SOCIETY

The seventh annual clinic of the Cleveland Dental Society will be held April 4-5 at the Hotel Statler.

OSCAR R. ROSEN, *Chairman,*
Publicity Committee,
562 Rose Bldg.,
Cleveland, Ohio.

### BALTIMORE COLLEGE OF DENTAL SURGERY ALUMNI MEETING AND COMMENCEMENT

The annual alumni meeting and commencement week activities of the Baltimore College of Dental Surgery, University of Maryland, will be held June 1-4.

GEORGE W. ANDERSON, *Chairman,*
831 Park Avenue,
Baltimore.

### CLASS OF 1923 NEW YORK COLLEGE OF DENTISTRY REUNION

A reunion of the class of 1923 of the New York College of Dentistry will be held at 106 West Fifty-Fifth St., New York City, April 7. Questionnaires are being mailed to members and those not receiving them are asked to forward addresses to

M. J. FUTTERMAN,
2021 Grand Concourse,
New York City.

### ST. LOUIS UNIVERSITY DENTAL ALUMNI ASSOCIATION

The St. Louis University Dental Alumni Association will hold its eighth annual reunion March 23-24, when a Saint Apollonia plaque will be awarded.

IRWIN B. DUNHAUPT,
5035A North Broadway,
St. Louis, Mo.

### MONTREAL DENTAL CLUB CLINIC

The fourteenth annual fall clinic of the Montreal Dental Club will be held October 12-14 at the Mount Royal Hotel, Montreal.

FRANK A. EDWARD, *Chairman of Publicity,*
Medical Arts Bldg.,
Montreal, Canada.

### ASSOCIATION OF FRENCH-SPEAKING DENTISTS OF NORTH AMERICA

L'Association des Dentistes de Langue française de l'Amerique du Nord is holding its annual convention in Montreal at the Mount Royal Hotel, June 2-5. The practicing dentists of French descent or having any relation with the French-Canadian population of the Province of Quebec are requested to send their names and addresses to

EPHREM VINET, *Chairman,*
Committee on Propaganda,
362 East St. Joseph Blvd.,
Montreal, P. Q.

### NATIONAL BOARD OF DENTAL EXAMINERS

The National Board of Dental Examiners will hold a session for the examination of candidates in Parts I and II, May 6 and 7, in such cities as five or more candidates request. For information and application blanks, address

MORTON J. LOEB, *Secretary,*
66 Trumbull St.,
New Haven, Conn.

### INDIANA STATE BOARD OF DENTAL EXAMINERS

The next examination for licensure of the Indiana State Board of Dental Examiners will be held in Indianapolis beginning June 14. All applications, fees and credentials must be in the hands of the secretary not later than ten days before the beginning date of examination. (This requirement will be absolutely enforced.) For applications, instructions to candidates and other information, address

J. M. HALE, *Secretary,*
Mt. Vernon.

## GEORGETOWN UNIVERSITY SCHOOL OF DENTISTRY ALUMNI CLINIC

The second annual anniversary Alumni Clinic of the Georgetown University School of Dentistry will be held in Washington, D. C., February 5.

FRANCIS J. FABRIZIO, *Publicity Chairman,*
839 17th St., N. W.
Washington, D. C.

## MIDWINTER MEETING OF CHICAGO DENTAL SOCIETY

The Seventy-Fourth Annual Midwinter Meeting of the Chicago Dental Society will take place this year February 14-18 at the Stevens Hotel in Chicago. For the first time in its long history, the meeting will cover five full days and this additional time has allowed the establishment of many new features. The Midwinter Meeting of 1938 will again feature a program that involves every branch of dentistry; lectures by men of national reputations in their field; clinics by those who have established themselves as experts; exhibits, both scientific and commercial, that will touch on new enterprises and new products; general sessions devoted to important discussions of professional and social interest; entertainment and amusement at the many functions that have been planned for the visitors.

Owing to the additional time on the program this year, two half-day sessions of clinics will be held. About 200 clinicians from all sections of the country will participate. Another feature to be held this year for the first time is that many of the essayists will give clinics in the section rooms. This will give the visitor an opportunity to see the practical details of the technics that have been presented in the lectures. About seventy-five commercial firms will present clinics on their products the opening day of the meeting.

Two important general sessions will be held. On one of the programs, the Hon. Samuel B. Pettengill, Representative in the United States Congress from the State of Indiana, will discuss "The Individual in a Free Society." Representative Pettengill is known as one of the leading members of the lower house of the Congress and has made many important and constructive contributions to national legislation. Another general session will be devoted to an exposition of the research work that has been done on the subject of caries by the group from Northwestern University. The interesting and far-reaching results that have been obtained by investigation in this field will be presented by several of the men who are engaged in active research.

The largest program of commercial clinics in the history of the Midwinter Meeting will be one of the chief attractions of the convention. In addition, there will be an imposing list of Scientific Exhibits, much enlarged from those of previous years. A new venture by the Public Relations Committee will be a health and education exhibit devoted to interesting material in that field.

The social side of the meeting has not been neglected. The Frolics and annual vaudeville show will be held on Monday night with a large program of new and entertaining acts. The Ladies' Luncheon will be given Wednesday noon, and Wednesday night, the annual supper-dance.

William E. Mayer, president, his staff of officers and all of the members of the Chicago Dental Society, join in extending an invitation to all to attend the Midwinter Meeting. Its rich program of professional and scientific material, its social events and its important part in promoting closer relationships between members of the profession all serve to make the coming Midwinter Meeting one of the most important dental meetings of the year.

## EXAMINATION FOR APPOINTMENT IN THE DENTAL CORPS OF THE NAVY

A competitive examination to select not more than twenty for appointment in the Dental Corps of the Navy will be held July 5 at the Naval Medical School, Washington, D. C.; Naval Training Station, Great Lakes, Ill., and Naval Training Station, San Diego, Calif. A candidate for appointment in the Dental Corps must be a citizen of the United States, and must be between 21 and 32 years of age at the time of appointment, a graduate of a standard dental college, of good moral character and of unquestionable professional repute. Credentials relative to character, citizenship, date of birth and education must be submitted and approved before an applicant can be authorized to appear for examination. A circular which contains full information relative to the Dental Corps and describes the method of making application for appointment can be obtained from the Bureau

of Medicine and Surgery, Navy Department, Washington, D. C.

## FIFTH ANNUAL POSTGRADUATE COURSE IN PERIODONTIA

New York University College of Dentistry will hold its fifth annual postgraduate course in Periodontia for two weeks beginning June 20. The course is limited to fifteen men. Preference will be given in order of receipt of application. The course will include etiology, diagnosis and treatment of periodontal disease. Various technics of pocket eradication will be considered and conservative treatment stressed. Vincent's infection; diagnosis of types of bone resorption; mouth manifestations of systemic disease; periodontal foci of infection; toothbrushing; instrumentation, and balancing of occlusion will be thoroughly covered. The classes will be taught by lectures and clinical work, each student treating several cases. Instruction will be given by Samuel Charles Miller, Sidney Sorrin, J. Lewis Blass, and the entire periodontia faculty.

For information and application, address the Periodontia Department, New York University College of Dentistry, 209 East 23rd Street, New York City.

## ARPA INTERNATIONALE

The Seventh Congress of the ARPA Internationale will be held August 26-28 in Prague, Czechoslovakia. The preliminary program is as follows:

I. Significance of C-avitaminosis in diseases of paradentium. Reports of Vitamin C Commission of the Arpa Internationale.

II. Paradentosis and the practitioner.

1. Anatomy, histology, physiology and pathologic anatomy.

2. Roentgenology of paradentium.

3. Clinical observation with special regard to the status of paradentosis.

4. Internal examination of patients suffering from paradentosis.

5. Significance of traumatic occlusion.

6. Functional treatment of cases of paradentosis.

7. Partial dentures.

8. Medicinal and surgical treatment of diseases of paradentium.

9. Prophylaxis of disease of paradentium with special regard to functional orthopedics.

10. Constitutional basis of paradentopathy.

Ten essayists and ten discussers.

III. Free lectures.

Any one wishing to present a free lecture and practical demonstration clinic must notify Karl Breuer, Státní ustav pro zubní lékarství, Prague, Fochova 64, Czechoslovakia, before February 15.

## FIVE-STATE POSTGRADUATE CLINIC

The District of Columbia Dental Society will be host to the Five-State Postgraduate Clinic March 6-9 at the Mayflower Hotel, Washington, D. C. The program committee of the District of Columbia Dental Society has arranged a clinic based on the slogan "Dental Health for American Youth," suggested by C. Willard Camalier, President of the American Dental Association, for the 1938 session of the national association. Among the essayists will be Lon W. Morrey, director of the Bureau of Public Relations of the American Dental Association; Malcolm W. Carr, New York City, oral surgeon at New York Polyclinic Hospital and Medical School; Oscar V. Batson, professor of anatomy, Graduate School of Medicine, University of Pennsylvania, Philadelphia, Pa.; Albert J. Irving, New York City; Rudolf Kronfeld, professor of histology, Chicago College of Dental Surgery, Chicago, Ill., and Alexander H. Paterson, professor of prosthetic dentistry, University of Maryland. March 9, the entire day will be devoted to table clinics. March 7, a reception will be held in honor of the President of the American Dental Association, Dr. Camalier, of Washington.

JOSEPH F. MANLEY, *Chairman,*
Publicity Committee,
1726 Eye St., N.W.,
Washington, D. C.

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1937-1938

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